THE AMERICAN ENCYCLOPEDIA AND DICTIONARY OF OPHTHALMOLOGY

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ASSISTED BY A LARGE STAFF OF COLLABORATORS

FULLY ILLUSTRATED

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Solution, Dobell's to Toxic Amblyopia

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Solution, Dobell's. See **Dobell's solution**, p. 4055, Vol. VI of this *Encyclopedia.*

Solution, Fowler's. See **Fowler's solution**, p. 5280, Vol. VII of this *Encyclopedia.*

Solution, Labarraque's. See **Solution of chlorinated soda, U. S.**, following here.

Solution of chlorinated soda, U. S. LABARRAQUE'S SOLUTION. This liquid is an aqueous solution containing sodium hypochlorite, sodium chloride and sodium carbonate, with about 2.5 per cent. of available chlorine. It is a pale-greenish liquid with a chlorine odor and a disagreeable, alkaline taste; powerfully germicide. It is used like chlorine water (q. v.) as an ocular disinfectant in one to three per cent. mixtures with water. As an antiseptic irrigating fluid—especially when there is much muco-pus—it should be employed warm in the proportion of one part to fifty of water. See **Solution, Carrel-Dakin.**

Solution of formaldehyde. See **Formalin**, p. 5474, Vol. VII of this *Encyclopedia.*

Solution of iodine in glycerine-carbolic acid. See **Phenol, Iodized**, p. 9630, Vol. XII of this *Encyclopedia.*

Solution of potassium arsenite. See **Fowler's solution.**

Solution, Panas'. One part of mercuric iodid dissolved in 400 parts of alcohol and 20,000 parts of water: used locally in eye inflammations.

Solveol. This is a brown, transparent, oily, alkaline liquid, miscible with water, containing about 25 per cent. of free cresol and 75 per cent. of sodium cresol. This antiseptic is used as a detergent germicide in which instruments may be safely immersed. Burchardt advises 1 part of lysol, 2 parts of solveol and 1000 parts of distilled water as an effective disinfectant which does not affect cutting instruments. It is much less poisonous and more effective as a disinfectant than carbolic acid.

Somniferin. 1. A derivative of morphin, said to be safer and more effective than morphin. 2. A narcotic alkaloid from *Withánia somnifera.*

Somnoform. This anesthetic preparation is a mixture of methyl chloride, 35 parts; ethyl chloride, 60 parts; ethyl bromide, 5 parts. In other words it is a combination of three anesthetic drugs, each more

or less dangerous, although it is claimed to be a safe and rapid anesthetic.

Its action is mainly that of ethyl chloride and if used continuously during a protracted operation or in large quantities may kill the patient by respiratory failure. It is not suitable for ophthalmic operations, as the ocular muscles (especially the powerful orbicularis palpebrarum) are among the last to yield to its influence and to become thoroughly relaxed. When this necessary condition is finally attained the patient has inhaled so much somnoform that he has entered the dangerous stage. Even then the duration of the anesthetic is not more than 90 seconds.

Vomiting is a frequent sequel, thus rendering it still more unsatisfactory for ophthalmic operation. See, also, p. 430, Vol. I of this *Encyclopedia*.

Sonnenmayer, Professor. A German ophthalmologist, who lectured on his specialty at Marburg about the middle of the 19th century. He published a book whose translated title is *"The Ophthalmia of the New-Born."*—(T. H. S.)

Sonnin. An antiseptic compound of boric acid and phenols.

Sonorous focus. The point at which vibrations of sound are collected by a mirror or by a lens composed of such material as to refract them.

Soot-balls. CORPORA NIGRA. UMBRACULUM. Black, spongy masses, consisting of portions of the uvea, sometimes seen at the edges of the pupil and in the anterior chamber of the eye. See **Comparative ophthalmology.**

Sophol. A proprietary preparation of formaldehyd, nucleic acid, and silver (22 per cent.). It has recently enjoyed considerable favor in the treatment of infectious eye diseases.

It was employed by Bock (*Prac. Med. Series*, Eye, p. 253, 1909), (usually in a 5 per cent. aqueous solution), who found it to be especially valuable in ophthalmia neonatorum and of service in all affections of the conjunctiva accompanied by profuse discharge. It is a mild, non-irritating bactericide, and its action is superficial.

Bondi (*Ztschr. f. Augenh.*, xxi, p. 517, 1910), from nearly two years' experience with it in a variety of conjunctival and corneal inflammations, finds sophol scarcely irritant, not at all caustic, and a bactericide that controls the conjunctival discharge. The 5 per cent. solution causes no irritation, the 10 per cent. solution occasions slight burning in a few cases, lasting only two or three minutes. Even the powdered drug can be used without causing as severe symptoms as some of the older astringents in common use.

Zade and Barcziuski (*Oph. Year-Book*, p. 39, 1914) report the results of tests made to determine the relative bactericidal and inhibitory power of sophol. As regards inhibition they found a dose of 0.5 per cent. sophol solution equivalent to 0.1 per cent. corrosive sublimate, 0.25 per cent. silver nitrate, 2.5 per cent. colloidal silver protargol. As regards bactericidal effect sophol was decidedly irregular. In the average a 1 per cent. solution was equivalent to 0.2 per cent. of corrosive sublimate, 0.25 per cent. of silver nitrate, 5 per cent. colloidal silver, 1 per cent. ichthargan, 1 per cent. albargan, and 2.5 per cent. protargol.

Stein (*Annals of Ophthalm.*, p. 411, 1917), from an experience of four years in its use, believes sophol "four times as efficient as a prophylactic as compared with nitrate of silver." To obtain this efficiency a proper technic in its employment is necessary. Two persons are required, one to pry apart the lids, using small pledgets of gauze or cotton, the other to administer the drug. One drop of a 5 per cent. solution is instilled directly into the eye and a second drop placed at the inner canthus when the lids are closed. The latter is to insure disinfection of the lid margins.

Sophorin. A volatile, liquid alkaloid obtained from the seeds of *Sophora speciosa.* Its chloride forms crystals and it is said to act like Calabar bean. See **Cytisin**, p. 3702, Vol. V of this *Encyclopedia.*

Sora. Urticaria.

Soranus of Ephesus. An excellent ancient physician, obstetrician and ophthalmologist, accounted of all the Methodists the very best. He was born at Ephesus in Asia Minor, a son of Phœbe and Menander, and practised medicine in Rome in the reign of Trajan (A. D. 98-117) and Hadrian (A. D. 117-138). He seems to have written fourteen books, of which the greatest, *"On Diseases of Women,"* another *"On Chronic Diseases,"* and one on anatomic nomenclature have come down to our day. His book, *"On the Eye,"* not now extant, is mentioned by Cassius Iatrosophistus. Soranus recommended the use of oil for ophthalmia neonatorum.—(T. H. S.)

Sore, Oriental. A name given by Tilbury Fox to any one of the diseases occurring in the East which have the general characters of Aleppo and Delhi boil. Biskra button, etc. See p. 217, Vol. I of this *Encyclopedia.*

Souchet élégant. (F.) Cyperus elegans.

Soufre. (F.) Sulphur.

Soul-blindness. A state in which the power of interpreting visual impressions is lost, without the sight being impaired. See p. 1175, Vol. II of this *Encyclopedia.*

Sound vision. See **Optophone,** p. 9103, Vol. XII of this *Encyclopedia.*
Sounds, Lachrymal. See **Probes,** p. 10387, Vol. XIII of this *Encyclopedia.*
Source primitive de lumière. (F.) Self-luminous body.
Source secondaire de lumière. (F.) A body shining by reflected light.
Sourcil. (F.) The eyebrow.
Sourcilier. (F.) Corrugator supercilii.
Sous-exposition. (F.) Under-exposure.
Sous-palpébral. (F.) A name given by G. St.-Hilaire to the coronoid bone in the crocodile.
Souter's ophthalmophakometer. See **Refraction and accommodation of the eye;** as well as p. 8934, Vol. XII of this *Encyclopedia.*
Southern-wood. CARLINE THISTLE. CARLINA ACAULIS. The leaves of this plant, rubbed up with the blood of a frog, were much esteemed by ancient Greco-Roman ophthalmologists as a means of preventing the recurrence of trichiasis after epilation.—(T. H. S.)
Sow's bread. The same as hog's bread. *Cyclamen europaeum.* In ancient Greco-Roman times, the juice was used for cataract and the affections vaguely known as "weakness of the sight."—(T. H. S.)
Sow's fennel. The same as "hog's fennel," *Peucedanum officinale.* It was used by Pliny and Dioscorides for hypochyma (cataract-?) caligo, and epiphora.—(T. H. S.)
Sozoiodole. SOZOIODOLIC ACID. See **Sodium sozoiodolate.**
Sozoiodole-sodium. See **Sodium sozoiodolate.**
Sozoiodole-zinc. ZINC SOZOIODOLATE. ZINC DUODOPARAPHENOSULPHONATE. This salt occurs in colorless, odorless, needles, soluble in 25 parts of water; also dissolved by glycerin and alcohol. It is a powerful antiseptic and astringent and in ocular therapeutics has been used in cases where soluble zinc salts are indicated, chronic conjunctival catarrh, angular conjunctivitis (q. v), etc., in one-fifth to 2 per cent. solutions; in salve form a little stronger.
Sozolic acid. See **Aseptol,** p. 639, Vol. I of this *Encyclopedia.*
Space, Circumlental. The space between the ciliary body and equator of the lens.
Space, Corneal. The space between the layers of the cornea.
Spaces, Interlamellar. The spaces between the lamellæ of the cornea.
Space sense. See **Sense, Space.**
Spaces of Fontana. Cavities between the processes of the ligamentum pectinatum iridis communicating with the anterior chamber of the eye.
Spaces, Zonular. The intercommunicating spaces between the fibers of the suspensory ligament of the lens: also called canal of Petit.

Space, Tenon's. A lymph-space between the fascia of Tenon and the sclerotic.

Spangenberg, George August. A German physician, who devoted considerable attention to diseases of the eye. Born at Butzow, Germany, Dec. 10, 1779, the oldest son of the well-known doctor, Peter Ludolph Spangenberg, he received his medical degree in 1801 at Würzburg, practised first at Braunschweig, later at Hamburg, held numerous official positions, removed to Albano, near Rome, on account of ill health, and there died July 8, 1837.

His only ophthalmologic writing was entitled "Ueber die Entstehung der Form des Hornhautsaphyloms" (Horn's *Archiv f. Med. Erf.*, V, 1804).—(T. H. S.)

Spanish flies. See **Cantharides**, p. 1383, Vol. II of this *Encyclopedia.*

Spannung des Augapfels. (G.) Tension of the eye.

Spar, Iceland. Calcite. See **Iceland spar**, p. 6135, Vol. VIII of this *Encyclopedia.*

Spark-condenser. A glass tube or other vessel, within which electric sparks may be produced for chemical or spectroscopic tests.

Spark, Henry Langlands. An English ophthalmologist. Born in 1886, he graduated at the University of Edinburg in 1901, and practised at Bradford, England, about five years. He was for a time surgeon to the Royal Eye and Ear Hospital at Bradford. He died of pericarditis late in 1909.—(T. H. S.)

Spasm, Arterial. This condition is said to be present, among other conditions, in epilepsy (see **Epilepsy, Retinal**, p. 4491, Vol. VI), arteriosclerosis (Wagenmann) and in Raynaud's disease (see p. 10883, Vol. XIV), but Parsons (*Pathology of the Eye*, p. 1259) thinks that ophthalmoscopic evidence in these or in other instances as to the eye should be received with caution. The *argumentum pro* is drawn up under **Cramp of retinal vessels**, p. 3550, Vol. V of this *Encyclopedia.*

H. D. Bruns (*Ophthalmology*, Jan., 1911), in recording a case of *spasm of the retinal arteries*, has reviewed the literature of the subject. In addition to the experience of Wagenmann (*Archiv f. Ophthalm.*, 38, p. 25), he quotes Noyes (*Diseases of the Eye*, 1890), who believes that in consequence of vasomotor irritation, the retinal arteries may be firmly contracted and arrest completely the circulation. and cites several cases in proof of this contention.

Bruns also quotes the following authorities:

Arterial spasm in migraine. Parisotti (*Ann. d'Ocul.*, cxix, p. 321), in a case of ophthalmic migraine, examined the eyes ophthalmoscopically. He found the lower half of the field gone; the arteries of the

upper half of the retina were narrowed; those of the lower half, normal. After the disappearanee of the hemianopsia the arterial spasm was gone.

Quaglino (*Ann. d'Ocul.*, lxv, p. 129): A thirty-four-year-old teacher, who, as a child, suffered from scrofulous keratitis and later from asthenopia, had attacks of migraine, especially if the meal-times were unduly postponed. The attack lasted from five to fifteen minutes, with transitory blindness, during which elliptic light figures with brighter rays were seen above. During the attacks the retinal arteries were narrowed.

In Siegrist's cases of hemicrania (*Mittheil. aus Kliniken der S.*, 10, 1894) the eye-grounds were twice examined and the retinal arteries on the side of the pain were markedly contracted.

In *helminthiasis* Farravelli (*Ann. di Ottal.*, xvi, p. 63, 1887) reports the case of a baker, thirty years old, who, while at work, was attacked with violent photopsia, followed by veiling of the sight of the right eye. Throughout a week the phenomenon was repeated each night two or three times; then a rest of a few months was followed by a more violent recurrence. The dimness increased to momentary blindness of the right eye, with lesser obscuration of the left, passing off completely in ten minutes. The ophthalmoscope showed anemia of the retinal arteries and congested and pulsating veins, the appearances being more marked on the right side. During the intervals between attacks the vision was normal. After a tape-worm, without the head, had been evacuated, the patient was free from attacks for two months, but with the reappearance of segments of the worm the eye symptoms recurred. The head having been expelled, the patient remained well.

Retinal spasm in eye diseases of unknown etiology. Alexander reports (*Deut. Med. Woch.*, No. 40, 1881) the case of a nineteen-year-old girl who complained for eight days of increasing dimness of vision (R. E. = 18/200). There was concentric narrowing of the field, but the color perception was normal. The pupils were sluggish; eye-grounds normal. The diagnosis of retrobulbar neuritis was made. After fourteen days vision had sunk to 3/200. All the retinal vessels were now found to be much narrower, the arteries hair-like, and hard to differentiate from the veins. Arterial pulsation could be produced by slight pressure. The macula was intact. The conclusion was reached that the case was not one of embolus, but, on the contrary, one of vasomotor cramp of the vessel-walls, and amyl nitrite was given. In four months all the phenomena had disappeared and vision was normal.

Retinal spasm after infection. Two cases of Ramorino (*Ann. di Ottalm.*, vi, 1, p. 25) of spasm of the retinal vessels in *malaria.* The principal symptoms were periodic amblyopia, with, during the attack, white papillæ, thread-like, almost bloodless, arteries, and scarcely perceptible veins. Cure by quinin.

After intoxication. With antifebrin: Hilbert (*Memorabilien,* 2, p. 5, 1895); with bromid of potassium: Rübel (*Centralbl. f. Augenheilk.*, October, 1884); with quinin, large number of cases; with lead, chronic poisoning.

Allen Greenwood (*Jour. Amer. Med. Assoc.*, March 11, 1905) believes that spasm of the retinal arteries may occur *in arteriosclerosis* of sufficient degree to cause a temporary partial or complete obstruction to the flow of blood, seems proved beyond a doubt. It has been the good fortune of several observers to see patients during an attack of spasm of the retinal vessels, where, for a few moments, the arteries were reduced to yellow streaks, with subsequent restoration of the circulation. Such patients give a history of more or less frequent attacks of complete or partial blindness of one eye, lasting from several minutes to an hour or two. He reports a case with such a history, and in which there were evidently attacks of spasm preceding the final complete obliteration of the inferior temporal artery. It is his belief that spasm occurs most frequently in early stages of arteriosclerosis, and should be looked upon as a warning of future obliterating arteritis. Wagenmann's case of repeated spasm finally had a spasm that was not relieved, and, the arteries remaining closed, the picture of embolus was produced. The writer thinks that only temporary spasm occurs in healthy vessels with normal blood, but that patients with retinal arteriosclerosis complicated by recurrent attacks of spasm are in special danger of blindness is evident. Virchow, many years ago, pointed out the fact that the arterial walls would close around an embolus, thus making an obstruction more complete. This contraction or spasm was only temporary, and it is only rational to expect that it would be a frequent and a recurrent accompaniment of endarteritis. Zehender was the first, according to Ole Bull, to call attention to arterial spasm, and in 1866 he published a case of repeated spasm of the retinal arteries following the repeated use of an ice-bag.

Retinal spasm in ischemia of the retina. Soelberg Wells refers to the cases of Alfred von Graefe (*Arch. f. Ophth.*, viii, 1, 143), Rothmund (*Klin. Monatsbl.*, 1866, p. 106), and Heddäus (*ibid.*, 1865, p. 285), and remarks that in the case of von Graefe the patient, a little girl, five and a half years of age, suddenly, overnight, became totally blind in both eyes, so that not the faintest perception of light remained.

On examination the eyes presented the following appearance: The tension, normal; conjunctivæ very pale, the eyeballs of marble whiteness, pupils much dilated, without any reaction on the stimulus of light, but a faint uniform contraction on the application of laudanum; only slight increase in dilation on the application of atropin. With the ophthalmoscope the dioptric media were found transparent, the retinal arteries extremely attenuated, the veins tortuous and dilated. The retina and optic nerve were normal, the outline of the latter being, however, slightly indistinct. The color of the skin, but especially of the mucous membranes, was extremely pale. The child was otherwise perfectly well, the only peculiar symptom being extreme rapidity of the pulse, which was very small and numbered 160 beats to the minute. Von Graefe considered that the probable cause of the blindness was an insufficient supply of blood to the retina, the faint and rapid contractions of the heart not being sufficient to overcome the normal, but proportionately too considerable, intra-ocular tension; he, therefore, gave the name of "ischemia retinæ" to this affection. The correctness of this view of the cause is strengthened by the fact that, after all other remedies, such as mercury, suppurating blisters behind the ears, artificial leeches to the temples, etc., had failed, an iridectomy, made upon the right eye ten days after the complete loss of sight, proved successful.

Rothmund mentions two similar cases of ischemia of the retina in which paracentesis proved effectual, having, however, to be repeated in the second case.

Spasm, Conjugate. One of the causes of *conjugate lateral paralysis* (see p. 3001, Vol. IV) is a forced and spastic movement of the eyes to one side, and this is known as conjugate spasm.

Spasm, Facial. See **Facial spasm**, or **Blepharospasm**, p. 1112, Vol. II of this *Encyclopedia*.

Spasm, Habit. A name given to such conditions as tic douloureux.

Spasm, Mimic. See *Tic douloureux,* under **Neurology of the eye.**

Spasm, Nictitating. Same as winking.

Spasmo delle palpebre. (It.) Spasm of the lids.

Spasm of accommodation. Spasm of the ciliary muscles, producing excess of accommodation for near objects. See p. 53, Vol. I, as well as **Refraction and accommodation of the eye**, in this *Encyclopedia.*

Leslie Paton (*Brit. Jour. Ophthalm.,* p. 329, 1918) defines *functional spasm of accommodation* to mean the *sudden development in one or both eyes of a high degree of apparent myopia,* disappearing under the use of atropin. The spasm may be either continuous or clonic;

or it may pass from a clonic to a continuous condition, and may be associated with spasms of the other ocular muscles. He reports a case in a young woman with low hyperopic refraction and occasional convergent strabismus in childhood. Later divergent strabismus of the left eye developed with diplopia, the refraction having changed to low myopic astigmia. Tenotomy of an external rectus was followed by homonymous diplopia. Some months later an apparent myopia, of 7 and 9 D., respectively, had developed in each eye, which vanished almost entirely under atropin, to reappear as soon as the atropin was given up. She was seen by Landolt, whose opinion was that as the spasm had followed the tenotomy of an externus, it must be in some way due to the interference with muscle balance produced by this tenotomy, and his suggestion was to advance the tenotomized muscle to its original position. Under the anesthetic, the visual axes were found to be parallel if not slightly divergent: the advancement caused a divergence of about 15 degrees. Her subsequent history is that her eyes vary from a condition of divergence with very little spasm, to convergence with spasm of 9 or 10 D. She will go on comfortably using the right eye for some weeks without spasm; but getting it at once on attempting to use the left eye, and then suddenly will find that the position is reversed when she can only use the left eye.

In a second case, a soldier who had suffered a slight concussion of the brain five months previously, there was marked spasm of convergence, blepharospasm and great limitation of visual fields. The refraction in each eye without atropin was —6 D.; under full atropin he proved to be hypermetropic I D. in each eye. Seven months subsequently all trace of spasm had gone. Visual fields normal and vision 6/6 in each eye without any glass.

Spasm of the ocular muscles. See **Cramp of the ocular muscles**, p. 3550, Vol. V, as well as **Muscles, Ocular,** in this *Encyclopedia.*

Spasm of the orbicularis. See **Blepharospasm**, p. 1112, Vol. II of this *Encyclopedia.*

Spasm of the retinal arteries. See **Spasm, Arterial** and **Retina, Ischemia of the.**

Spasmus nictans. Spasmodic winking or blinking of the eyelids, of the same nature as clonic spasm of the orbicularis palpebrarum.

Spasmus nutans. SPASMUS NICTANS VEL NICTITANS. According to Thomson and Spicer, infants with spasmus nutans sometimes show a form of nystagmus in which the eyes alternately and rhythmically converge and diverge; or the nystagmus may be dissociated, in which the movements are horizontal in one eye, and vertical, rotary, or oblique in the other. According to Schapringer, the nystagmus may disappear from

one eye before the other. It may be limited to one eye. The direction of the head movements and the nystagmus is usually the same, but is often different.—(J. M. B.)

Spasmus oculi. Nystagmus.

Spasm, Winking. Spasmodic twitching of the orbicularis palpebrarum muscle and of the eyelid.

Spastic ectropion. See p. 4140, Vol. VI of this *Encyclopedia.*

Spastic enophthalmos. In this (very rare) condition the eyeball is retracted by the simultaneous action of the four recti muscles. W. Förster has reported a case of spastic enophthalmos following forcible separation of the eyelids, the eyeball returning to its normal position when no force was applied. The patient was aged and emaciated. Two similar cases have since been reported.

Spastic ischemia. Vessel-cramp. Cramp of retinal vessels. See 3550, Vol. V; as well as **Spasm, Arterial** of this *Encyclopedia.*

Spastic miosis. This condition may occur in cases of hypersensitive retina, in hyperemia of the retina and optic nerve, in the first stages of alcoholic amblyopia, and as a result of excessive sexual indulgence. It is also noticed in the beginning of hysteric and epileptic attacks, in tobacco amblyopia, and in watchmakers and other habitual near-workers.—(J. M. B.)

Spastic rigidity of the limbs, Congenital. For the ocular complications see, under **Neurology of the eye,** the subsection *Congenital spastic rigidity.*

Spastic strabismus. This rare form of deviation of the eye is due to spasm of one or more ocular muscles. It includes some cases of intermittent comitant strabismus, of choreic squint, also of conjugate deviation the result of irritating cerebral lesions, hysteria, and epilepsy.

Spatel. (G.) Spatula.

Spatial. Spacial. Of, relating, or pertaining to, space.

Spatia zonularia. Same as Petit's canal. See p. 1378, Vol. II of this *Encyclopedia.*

Spatula. The ophthalmic spatulæ are flat, blunt, knife-like instruments employed for various purposes.

A typical *lid spatula* is described on p. 4346, Vol. VI and two others are depicted in this text.

A *corneal spatula* has been devised by C. H. Usher (*Ophthal. Review,* January, 1916), for the removal of foreign bodies that lie so deeply embedded in the cornea that there is risk during their extraction of pushing them into the anterior chamber unless some form of guard or support is placed against the posterior surface of the cornea.

For this purpose a keratome or broad needle is commonly recommended, and presumably has in general proved satisfactory. The presence in the anterior chamber of a flat blade with sharp point and edges, as that of a keratome, during the extraction of the foreign body has, however, some disadvantages and even dangers. On one occasion, during an attempt, in this manner, to remove from the cornea a deep-lying foreign body, the little particle dropped on to the keratome in the anterior chamber and gradually slid off the blade on to the lens. The cause of such an accident may be explained by the concavity of the posterior surface of the cornea preventing the flat keratome blade coming in contact with Descemet's membrane behind the site of the foreign body, so that a space is left between the blade and the cornea. If this be the correct explanation the anterior surface of the supporting blade should be made convex.

The spatula consists of a blade, a neck and a handle. The blade is circular with a diameter of 6 mm., its anterior surface in convex with a curvature corresponding to that of the posterior surface of the cornea, which with a radius of curvature of 6.8 mm., gives a maximum

Plain Lid Spatula.

thickness to the blade of nearly 1 mm., its posterior surface is flat, its edge blunt and smooth. The neck, 2 mm. in length, is added so that without increasing the diameter of the blade, the instrument can be used for foreign bodies at the center of the cornea. The handle set at an angle of 125° with the neck and blade, allows the blade to be conveniently introduced at the nasal edge of the cornea when necessary.

The advantages claimed for the instrument are that it is more likely to prevent a foreign body entering the anterior chamber during the manipulations for its extraction from the cornea and, as the blade is blunt, it is less liable to cause damage, especially when aqueous has escaped, during any movement of the eye in a restless patient, than a blade with a sharp point and edges, thus giving the operator more freedom to concentrate his attention on the actual removal of the foreign body. The instrument is obviously not suited for the removal of foreign bodies projecting into the anterior chamber.

A combined blunt-pointed probe and *iris spatula* is a common instrument for cataract cases. See **Cataract, Senile.** In this connection the Editor prefers, for stroking the cornea or for direct re-

placement of the iris, the flat side of a Daviel spoon, although in replacing the columns of a coloboma the flat spatula or iris-repositor is, perhaps, better. When used for reposition of the iris, the spoon should have a shallow, concave surface and its edges should be round and thick, while the body of the instrument should not be too broad. In this form it is an extremely useful instrument not only for replacing the iris but in using counter-pressure above the wound during extraction of the lens.

Trachoma and *blepharoplastic* spatulæ are described under their respective headings.

Lid Spatula (right or left) of Rochon-Duvignaud.

Specalette. See p. 4957, Vol. VII (with figure) of this *Encyclopedia.*

Specialism. Hamilton Weir (*Northwest Medicine,* Sept., 1911) defines a "specialist" as a graduate of a responsible medical school, a qualified licensed practitioner who has perhaps before, but certainly after graduation, further pursued the study of a certain branch of medicine or surgery, and who limits his practice strictly to that chosen department and refuses or refers to another any and all practice not properly within his limited line; further, one who refrains from prescribing outside his specialty even for patients under his care, if they are referred to him by a general practitioner, and who refuses under all circumstances, except possibly in emergency or in simple humanity, then without remuneration, calls or demands for general medical or surgical attention.

To this strict interpretation, he further says, some may object, and it is probable that many who consider themselves specialists and are so accepted by the profession and laity, would fail to fulfil its requirements by a large margin, but he contends that any interpretation less strict would be unjust to the general practitioner, and that its honest fulfillment is necessary to proper professional conduct, to the rights of both specialist and general practitioner and their attitude and service to the public.

Any practitioner may and generally does have his preferences, his special abilities, even his dislikes of certain branches of practice, but so long as he answers calls for professional assistance and receives pay

for services rendered—or hopes to some time—he must be considered a general practitioner.

The writer's plea is for closer association of practitioner and specialist, for more frequent consultation, for increased confidence and exchange of professional courtesies, for more consideration of the rights and limitations of each, for full written reports and greater attention to the diagnosis, the value and necessity of such reports, for especial consideration of the rights of the practitioner who refers his patient to the specialist, but does not release or discharge him by so doing, for more specific information from the practitioner regarding the man as well as regarding the medical aspects of the patient he refers, for unity in treatment as well as generosity of service, and last, but not least, combined effort to protect each from the man who will not pay his bills.

Specific. (1) Produced by one agent or by one single kind of organism. (2) A remedy specially indicated for a particular disease.

Specific keratitis. A name for interstitial or parenchymatous keratitis. See p. 6789, Vol. IX of this *Encyclopedia*.

Specillum. (a) A lens; an eyeglass. (b) A surgical probe.

Specimens, Eye. See the major heading, **Laboratory technique,** p. 6887, Vol. IX of this *Encyclopedia*.

Speckled degeneration of the macula. In 1909 Nuel (*Oph. Year-Book,* Vol. VI, p. 242) reported a series of cases presenting rounded, light-yellowish spots in the macula. With these he published a figure of a section obtained from an injured eye, that he supposed to illustrate the nature of the lesion. It was then remarked: "Apparently Nuel has associated his accurate clinical observations of one condition with an anatomical study of a totally different lesion." The opportunity to examine microscopically one of the eyes he had formerly described has convinced him of this. He finds in this condition the pigment epithelium separated from the underlying membrane by a clear, solid homogeneous, finely granular exudate. The separation beginning very gradually at the margin, he thinks, distinguishes this condition from the "drusen" of German authors, which he supposes are more prominent and abrupt. Upon this, and other inadequate distinction, he separates the appearance in question from drusen of the choroid, and calls it speckled degeneration of the macula lutea.

Spectacle frames. For a complete account of these, see p. 4904, Vol. VII, *et seq.,* of this *Encyclopedia.* Having been much annoyed while playing tennis or doing any hard work in hot weather by sweat running down from his eye brows upon his glasses, H. Gifford (*Ophthal. Rec.,* February, 1915) has devised a *spectacle frame for tennis play-*

ers, farmers and others exposed to excessive heat. He has had a pair of gutters made in aluminum which screw on to the sides of the bridge and the outside posts, which prevent this trouble. The inner edge of the gutter fits close under the eye-brows and carries any excessive perspiration off to the sides. He thinks that the frame may find a larger application among farmers than among tennis players, as any one who has attempted to pitch hay or do other hard work in the hot sun, will readily appreciate. Many a farmer who ought to wear glasses either for visual purposes or to protect his only remaining eye, will not do so on account of the dimming of the glasses in hot weather.

Spectacle-gauge. An appliance for determining the proper distance between spectacle-glasses.

Spectacle-glass. (a) A spectacle lens. (b) Optical-glass.

Spectacle-maker. One who makes spectacles and similar instruments.

Spectacles. A pair of lenses set in a frame to correct, or assist, the sight. See **Eye-glasses and spectacles.**

Spectacles and eyeglasses, Adjustment of. See **Eyeglasses and spectacles, Adjustment of,** p. 4953, Vol. IX of this *Encyclopedia.*

Spectacles, Bifocal. Franklin spectacles. Pantoscopic spectacles. Spectacles with two half-lenses of different foci for each of the eyes: the upper half for distant, and the lower for near vision. See **Eyeglasses, History of,** and other captions.

Spectacles, Masselon's. Spectacles with an attachment for keeping the upper lid raised in cases of paralytic ptosis. See **Ptosis prop,** p. 10520, Vol. XIV of this *Encyclopedia.*

Spectacles, Minifying. A writer in the *Popular Science Monthly* (August, 1919) remarks that glasses for the purpose of *decreasing the size of the image* (probably concave lenses) and thus giving the impression of increased distance from the eye are a late addition to popular optical apparatus. They are intended for those whose fate, as late arrivals, consigns them to a front seat in the movie-show.

" 'Seats up front,' says the usher as you enter the moving-picture theater. But if you sit too near a moving picture the screen folk become monstrous, distorted figures moving around amid a great flickering that hurts the eyes. If you are in the habit of arriving late, you ought to own a pair of the moving-picture spectacles invented by Edward Lamphier, of Kalamazoo, Michigan. They are made like opera-glasses, but they have the reverse effect. Opera glasses bring things near; these glasses send things away. Converging lenses are mounted on the outside ends of the frames, and the eye-pieces are adjustably mounted on aluminum tubes within. The movie fan adjusts the eye-pieces to suit his particular focal length. A screen fif-

teen feet away will then seem to be forty-five feet away and flickering is reduced.''

Spectacles, Orthoscopic. A term applied by Scheffler to lenses cut out from the periphery of a large lens so as to act as decentered lenses.

Spectacles, Pantoscopic. A term applied to bifocal lenses.

Spectacles, Periscopic. Spectacles with either menisci or concavo-convex surfaces toward the eyes; these allow the eyes considerable latitude of motion and of distinct vision.

Spectacles, Prismatic. Lenses ground with prisms, or decentered for correcting muscular defects.

Spectacles, Pulpit. Spectacles containing the lower segments of the lenses only; a form of bifocal glasses.

Spectacles, Stenopaic. Spectacles fitted with metal plates, having each a small central aperture; used to assist vision in irregular astigmatism, scarred cornea—and, formerly, in the vain attempt to correct strabismus.

Spectacles, Turn-pin temple. Spectacle-frames in which the wings are jointed and the end pieces turned down behind the ears, giving the glasses a firmer support.

Spectacular. Relating to spectacles or other glasses for assisting vision.

Spectra, Entoptic color. In a communication to ''*Nature*'' (1918) Brudenell Carter stated that he had noticed, for some time past, before his eyes when directing his gaze upon bright lights, colored spectra in the shape of concentric circular bands—red external, blue internal and yellow intermediate. When the light is near, and so strong as to contract his pupils, the spectrum does not appear, and in like manner the circle is obliterated when he looks through a pin-hole opening.

His refraction is moderately hyperopic and astigmatic, but his spectacle lenses fully correct his visual defect, and he is able to read brilliant type. His color-sense is not defective and he has no cataracts. He regards the phenomenon, which has been complained of by other octogenarians, to be dependent upon altered refraction in the crystalline lenses through the changes commensurate with his advanced age.

Rhineberg, in commenting upon Carter's communication, assumes that the cause of the spectra is in some way due to diffraction. The appearance of the blue and red bands, and the diameter of the colored circles increasing in size in ratio to the distance of the light viewed, point to this; both their appearance when the pupil is widely dilated and their disappearance when the pupil is contracted. He quotes Tyndall's opinion in a case in which the philosopher ascribed

the colors to minute particles in the humors of the eye, the increase in size of circles and the vividness of the colors indicated that the diffracting particles were becoming smaller and that they might finally become absorbed.

This explanation Carter does not accept, but clings to his idea that the phenomena are due to lenticular inefficiency. He can not account for the presence of a cloud of particles in the ocular media of perfectly healthy, effective organs. He maintains that the occurrence is due to changes inherent with advancing years, for it is not probable that the cloud, if it existed, would be of similar density in the two eyes, or that it could exist without impairment of sight. In his own case the color circles of the two eyes are of equal size and brightness.

Spectral. Pertaining to ocular spectra, or to the solar, prismatic, or diffraction spectrum.

Spectral analysis. SPECTRUM ANALYSIS. See **Spectrum.**

Spectral colors. When a beam of sunlight is passed through a prism it is decomposed into a series of colored rays called the solar spectrum.

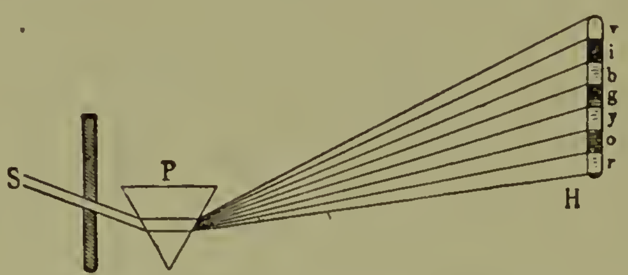


Diagram of the Decomposition of Solar Light into the Spectral Colors. (Jennings.)

These spectral colors are red, orange, yellow, green, blue, indigo, and violet. They are called simple colors because they cannot be further decomposed.

Spectral image. An image persistent in the retina, after the exciting cause is withdrawn.

Spectres oculaires. SPECTRES PERLÉS. (F) Muscæ volitantes.

Spectrobolometer. A bolometer mounted in conjunction with a spectroscope, so that the heat energy in different regions of spectra may be compared.

Spectro-colorimeter. A name applied by Vierordt to an ophthalmo-spectroscope that isolates a single spectral color; used in detecting color-blindness.

Spectrogram. A map or representation of a spectrum generally produced photographically.

Spectrograph. A spectroscope in which a photographically sensitive

plate replaces the eye-piece; an instrument for photographing or in any other way reproducing a spectrum.

Spectroheliograph. An apparatus for photographing a spectrum or for forming a representation of the spectrum in any way as first devised by Professor Hale of Chicago (1889), now of Pasadena, Cal., for photographing solar prominences. It consists of a spectroscope with a double slit, the second slit being for the purpose of excluding all light, except the K-line of calcium. By arrangement, a picture in monochromatic light can be built up in sections. The most powerful spectroheliograph is that erected on Mt. Wilson, Pasadena, California (1905).

Spectrology. The science of spectrum analysis.

Spectrometer. (1) A spectroscope having a graduated circle and vernier for determining the deflection of the telescope when directed upon different parts of the spectrum.

(2) An apparatus for measuring the angular deviation of a pencil of light subjected to refraction or diffraction.

Spectrometer, The Edridge Green color perception. See p. 2412, Vol. IV of this *Encyclopedia.*

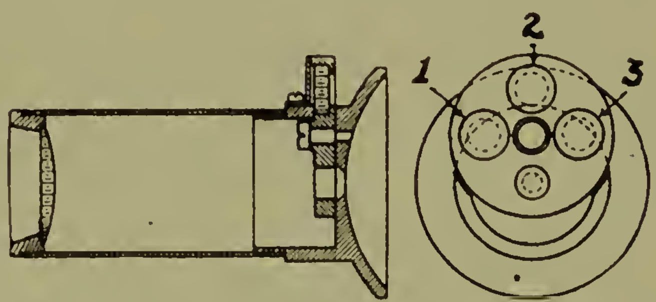
Spectrometric. Relating to spectrometry or the measurement of the deviation of a ray of light.

Spectrophone. An apparatus in which the principle of the radiophone is applied to the purposes of spectrum analyses.

Spectrophotometer. (1) An instrument for determining the relative intensity of two spectra, or of the corresponding bands of color in two spectra, one of the objects compared being taken as a standard. The spectra of the colors are brought side by side before the eye, and the difference in intensity is determined by the amount of angular change of an adjustable prism made to tone down the brighter of the two to the measure of the other. (2) An apparatus for measuring the light-sense by means of a spectrum. (3) An apparatus for estimating the quantity of coloring-matter in solution by the quantity of light absorbed (as indicated by the spectrum) in passing through the solution.

L. Bloch (*Electrical World,* p. 1172, Dec. 6, 1913) has investigated the color of light from electric-lamp sources. To characterize completely the color of artificial sources of light, a spectrophotometer may be used and the light of each wave-length determined separately, but this method is very complicated. Ives has already shown that any color is defined by the manner in which it is made up of the three fundamental colors—red, green and blue. The present author uses the same principles, employing for the purpose glass of well-defined

colors. Three colored glasses are inserted as round plates, 7 mm. in diameter and 1 mm. in thickness, in a revolvable disk in the photometer (as shown in the cut where 1 represents the red plate, 2 the green plate, and 3 the blue plate). The fourth hole is left open for making measurements in white light. Readings may be taken with any photometer. From the results of the measurement two numerical values are formed, namely, the ratio of red to green and the ratio of blue to green, corresponding to daylight with covered sky, for which both values are assumed to be 100. If the value of red to green is, therefore, 99.5 per cent. and that of blue to green is 29.5 per cent. (which are the characteristic values for intensive flame-arc lamps with carbons giving yellow light), it means that the light of the lamp in its richness of red light agrees almost exactly with daylight while there is a considerable lack of blue rays in the light. The author has determined these two characteristic values for all kinds of lamps.



Spectrophotometer with Three Colored-Glass Filters.

Spectropolarimeter. A combined spectroscope and polariscope for determining optical rotation.

Spectropolariscope. A combined spectroscope and polariscope.

Spectropyrometer. A form of spectrophotometer applied to the measurement of high temperatures.

Spectroscope. An instrument used for forming and examining spectra. It consists essentially of a collimator, one or more prisms, and a telescope. The collimator is a narrow vertical slit formed by the adjustment of two metallic jaws at the principal focus of a convex lens which so condenses the divergent rays of light received through the slit as to cause them to enter the prisms as a beam. This prism, or series of prisms, is so arranged that the edges are parallel to the slit; and thus a spectrum is produced which it is the function of the telescope to magnify. See **Spectrum analysis**; also **Spectrum projector**.

Spectroscope, Browning's pocket. One of the many devices for the scientific study of color-blindness. It consists of a compound direct-vision prism placed in a sliding tube, at one end of which there is a

lens, and at the opposite end a slit to admit the light. By the aid of this instrument the color-blind can tell whether the spectrum appears shortened and what colors he sees.—(C. P. S.) See **Color-sense and color-blindness.**

Spectroscope, Direct-vision. A spectroscope made by combining prisms of crown glass with one or more of flint glass. The edges of the prisms of crown and of flint glass are in opposite directions. The dispersion is given by the flint and the refraction is overcome by the crown glass prisms, so that the spectrum appears directly in the line of the source of light, instead of being bent as with a single prism. Used largely in the formation of spectral oculars or microspectroscopes.

Spectroscope, Ramsay's. This is a grating spectroscope of great utility for the examination of the color-sense, devised by Maitland Ramsay of Glasgow. See p. 2469, Vol. IV of this *Encyclopedia.*

Spectrum. Light emanating from any ordinary source is rarely if ever homogeneous. The heterogeneous character of the light is proved by the process of forming its spectrum. This is usually done by use of a glass prism interposed in the path of the ray, which on emergence at the farther side is found to be composed of differently colored parts. This experiment was discussed scientifically first by Newton. It is impossible to settle exactly the precise boundary between any two of the colors, which pass by insensible gradations one into another. The spectrum is produced because the differently colored constituents of sunlight have different refrangibilities, the red being refracted least of all and the violet greatest of all. If light of a particular refrangibility were absent or of less intensity than the other constituents gaps would appear in the spectrum. Such gaps do exist in the spectrum of sunlight, and were first observed by Wollaston in 1802. In 1817 Fraunhofer measured the relative positions of a great number of these *dark lines,* and named the more important of them by the early letters of the alphabet, A, B, C being in the red, D in the yellow, E in the green, F, G, H in the blue and violet. They are the standard lines with which it is usual to compare the line characteristics of other spectra.

For the careful observation of these lines the spectroscope and spectrometer has been constructed. It consists essentially of a prism or train of prisms; a collimator, at the focus of whose lens is placed a narrow slit, parallel to the edge of the prism; and a telescope for producing a magnified image of the spectrum of the illuminated slit. Nearly all transparent refractory substances give similar spectra, although the dark lines are somewhat differently spaced in the dif-

ferent cases. This shows that substances vary in their dispersive as well as in their refractive powers.

Another mode of producing a spectrum is by means of a diffraction-grating, which is formed by ruling a series of fine lines on a glass or metal surface. For the production of a good spectrum it is necessary that the lines should be equidistant and so close that several thousands go to an inch. When the light from an illuminated slit is passed through, or reflected from, such a grating, and is then focused on a screen, or viewed through a telescope, a remarkable appearance is presented. A central luminous line is seen, just as if no grating existed, and for some distance on either side the field is dark. But soon on both sides spectra appear, with their violet ends nearest the central line. Still farther to left and right secondary spectra appear, their violet ends perhaps overlapping the red ends of the primary spectra. These are followed by a third but fainter set, and so on. These successive spectra are due to diffraction, the same phenomenon which gives rise to the color of mother-of-pearl and to glories round the moon. The absolute position and breadth of the spectra depend on the closeness of the lines of the grating; but the relative positions of the colored rays in any spectrum depend only on the wave-lengths of the ether waves which constitute light. Thus in the solar spectrum produced by a diffraction-grating Fraunhofer's lines are so distributed that their distances from the central luminous line above mentioned are (very nearly) proportional to the wave-lengths of the corresponding rays of light. This spectrum is accordingly called the normal spectrum. Compared with it, the ordinary prismatic spectrum is much crushed towards the red end and extended towards the violet end. The construction of diffraction-gratings was greatly improved by Professor Rowland, of Johns Hopkins University. His photographs of the solar spectrum are amongst the best ever produced.

Spectrum analysis. Previous to the discovery of the principle which lies at the basis of stellar and solar spectroscopy, the great variety of spectra given by different substances had been recognized. Under the same conditions of temperature and pressure each substance gives the same spectrum. A white-hot solid substance gives a continuous spectrum not unlike the solar spectrum, but without the dark lines. A glowing gaseous substance gives a discontinuous spectrum, consisting in general of characteristic bright lines separated by dark spaces. The metal thallium was discovered by its spectrum. Now careful comparison shows that in many cases the bright lines which form the spectrum of a glowing vapor or gas correspond in position with dark lines in the solar spectrum. The conclusion is that the dark lines are due

to the absorption by these vapors or gases of those parts of the originally continuous spectrum which correspond to them, and that these vapors or gases are present in the outer atmosphere of the sun. This great principle of radiation and absorption, first clearly recognized by Stokes, was established by the researches of Balfour Stewart, Kirchhoff, and Bunsen.

The character of the spectrum of a given substance changes with temperature and pressure. For example, although hydrogen, like all gases, gives at ordinary pressures a bright line spectrum with sharp thin lines, these lines become broader and broader as the pressure is increased, until at very high pressure the spectrum becomes almost continuous like that given by a glowing white-hot solid. One tolerably safe conclusion to draw is that stars which all have continuous spectra crossed by dark absorption lines or bands consist of a highly condensed nucleus; whereas true nebulæ, which show bright line spectra, are luminous because of the presence of glowing gas in a comparatively attenuated condition. In the case of comets, the spectrum is faintly continuous with bright lines crossing it—a mingling of solar reflected light with the proper gaseous spectrum of the comet itself. The planets give, in like manner, the spectrum of sunlight modified more or less by the absorptive character of their atmospheres.

If a ray of sunlight, or a ray from the electric or lime light, is passed through various liquids, very characteristic absorption bands are obtained across the otherwise continuous spectrum. These so-called absorption spectra are of great service in discriminating between different solutions. For example, arterial and venous bloods give quite different absorption spectra.

A remarkable application of spectrum-analysis is to the measurement of the rate of approach or recession of any heavenly body. If we are approaching a star the waves of light will meet us at a somewhat quicker rate than if we were relatively steady with regard to it. That is, the waves of light will appear to be shorter—hence all the lines in the spectrum will be displaced towards the violet end. On the other hand, if we are receding from the star, the spectrum lines will appear to be shifted toward the red end.

Throughout this article we have confined our attention to the *visible* part of the solar spectrum. But the spectrum extends much farther than is apparent to the eye. Below the red are the dark heat rays, whose presence or absence can be demonstrated by the appropriate means. Langley was the first to study this region with the aid of rock-salt prisms and the bolometer, and carefully measured the positions of the absorption bands. Beyond the visible violet again are the invis-

ible actinic rays. This upper part of the spectrum can be made visible by allowing it to fall upon some suitable fluorescent substance, such as uranium glass or a barium platino-cyanide screen. Photography also supplies us with a perfect method for obtaining visible images of the actinic spectrum. Indeed, by proper choice of the sensitive substance a great part of the complete radiation spectrum can be photographed; and in the extended solar spectrum so obtained we find the same characteristics throughout—a continuous spectrum crossed by dark lines.—(*Standard Encyclopedia.*)

Spectrum, Absorption. A spectrum crossed with dark bands produced by the specific absorptive action of gases, liquids, or solutions of solids or translucent or transparent colored solids, such as monazite, on a beam of white light made to pass through them before falling upon the prism or other refracting medium. The position of the bands, which are called absorption bands, is constant for the same substance, but the breadth and definition of the bands depend to some extent on the degree of concentration of the absorbing medium.

Spectrum analysis. SPECTRAL ANALYSIS. See **Spectrum,** *supra.*

Spectrum, Chemic. That part of the spectrum which includes the ultra-violet or actinic rays.

Spectrum, Chromatic. That part of the spectrum which includes the visible rays.

Spectrum, Continuous. A spectrum uninterrupted by dark or bright lines crossing it; one in which Fraunhofer's lines are not developed.

Spectrum, Colors of the. See **Spectral colors.**

Spectrum, Diffraction. GRATING SPECTRUM. A spectrum produced by passing light through a grating or finely ruled glass plate or by reflection from a similarly engraved plate of any material. See **Spectroscope, Ramsay's.**

Spectrum, Fortification. See **Migraine.**

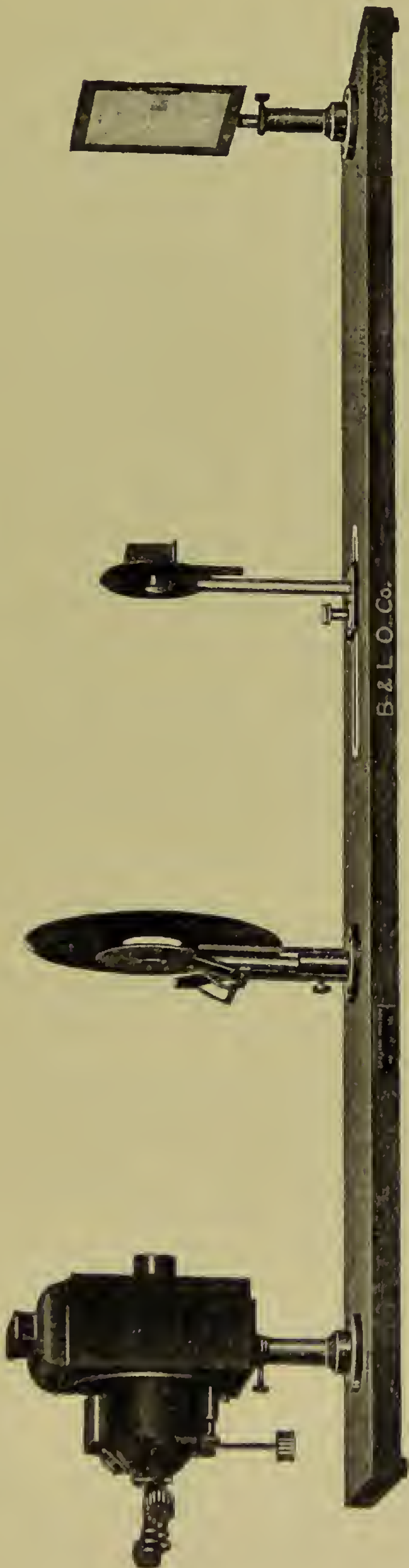
Spectrum, Gaseous. That afforded by an incandescent gas.

Spectrum, Muco-lachrymal. See **Muco-lachrymal Spectrum,** p. 7873, Vol. X of this *Encyclopedia.*

Spectrum, Ocular. Same as after-image. See p. 139, Vol. I of this *Encyclopedia.*

Spectrum projector. This form of spectroscope (q. v.) is an instrument designed to furnish a convenient and sensitive means of studying the absorbing effect of various substances on the visible and on the ultra-violet regions of the spectrum.

The principle of the apparatus is to project on a screen a brilliant spectrum of great dispersion, including both visible and ultra-violet light, and then to bring the material to be tested into the path of the light so that its effect on the spectrum may be determined.



Spectrum Projector.

The apparatus consists of a hand-feed arc lamp with rheostat for 4½ amperes, a quartz condenser fitted into the lamp casing, spectrum slit with object holder adjustable for large and small objects, focusable projection lens on sliding bed mounted with a detachable diffraction grating fixed to a prism for direct vision, and a small projection screen with an uranium glass strip so attached that the visual and ultra-violet spectrum may be observed simultaneously. The whole instrument is mounted on a wooden base and forms a compact, self-contained outfit. See the illustration.

The makers claim that the use of the apparatus is simple, and that the arc lamp may be connected to any ordinary house current. The rheostat usually supplied with this apparatus will accommodate 110 volts; if a higher voltage only is available, an additional rheostat is required. The arc lamp, being of a hand-feed type, may be used with either alternating or direct current, and a flexible cord with screw adapter to fit into any ordinary lamp socket is supplied with the apparatus. The carbons supplied with the arc lamp are of a special type in order to furnish an intense ultra-violet light.

Spectrum, Solar. The spectrum afforded by the refraction of a beam of sunlight. Under ordinary circumstances this is continuous, but when solar light is passed through a fine slit the spectrum is crossed by numerous dark lines called Fraunhofer's lines. See **Spectrum.**

Spectrum scotoma. The scintillating scotoma of migraine (q. v.).

Specular. Of, or pertaining to, a mirror.

Specular reflection. Glare from mirrors, walls and other reflecting surfaces.

Richards (*Oph. Year-Book,* p. 390, 1916) regards the glare due to the specular reflection from the painting, according to navy department orders, of the ceiling and side walls of "all offices, chief petty officer's state rooms, mess rooms and quarters, and crew's reception and reading rooms" a pure-white, glossy finish as a disadvantage which is real and readily apparent. A pale-yellowish buff, flat finish, is suggested as a substitute for the glossy, pure-white. While indirect illumination is considered far superior to direct, necessity requires the use of direct lighting on shipboard, almost exclusively; and Richards suggests the need of experimental data collected under service conditions to determine maximum and minimum requirements.

The committee of the British Association for the Advancement of Science report (*Brit. Med. Jour.,* Mar. 18. 1916, p. 424) that the specular reflection from gloss on paper is apt to interfere with binocular vision. That when the specular reflection does not exceed the diffuse reflection when the light is incident at 45 degrees the paper is satis-

factory; when the specular reaches 56 per cent. and the diffuse only 44 per cent., there will be injurious glare, especially with artificial light.

This subject is further discussed under the rubrics, **Glare** and **Illumination.**

Speculum. (a) A mirror. (b) An attachment to, or part of, an optical instrument. (c) A surgical instrument, by means of which internal parts of the body are rendered capable of being observed.

Speculum, Eye. BLEPHAROSTAT. This appliance for securing a continuous view of an ocular cavity or passage has already been depicted to some extent under **Lid retractor,** pp. 7456 and 7459, Vol. X; **Lachrymal diseases**; **Cataract, Senile**; **Blepharostat,** and other captions of this *Encyclopedia*.

A. E. Ewing (*Am. Journ. of Ophthalm.,* Feb., 1916) has made an exhaustive study of the subject and has collected drawings of more than a hundred of these devices dating from the earliest times to the present. He has also devised three new forms of blepharostat. We quote his writing somewhat in extenso, as follows: In the works on the surgery of the eye previous to 1854, and in many others to even a recent date, the diagrams of important operations on the globe show the lids held apart by the fingers. Also many operators do not hesitate in saying that this method of fixing the eyelids is preferred because of the lack of pressure on the globe, and the ease and the rapidity with which they may be released in case of serious complications. Probably the first instrument employed for holding the lids apart was the hook, resembling the ordinary strabismus hook but somewhat more curved (Pl. I, Fig. 1). This instrument is still employed in some eastern countries by those who know nothing of modern ophthalmology, and it is doubtless safe to assume that their operative procedures have undergone very little change for centuries. The illustration is a reproduction from the one in Hirschberg's *Geschichte der Augenheilkunde,* Vol. I, p. 208, 1905, where it is credited by him to Drake-Brockman. In the same volume, page 198, Hirschberg reproduces hooks from the work of Arab Halifa, 1266, which are assumed by him to be hooks for elevating the eyelids, and in Graefe-Saemisch, Vol. XIV, pp. 188-9, 2nd ed., he remarks that the hook was employed by the Greeks for this purpose, citing Aetius as his authority. This illustration from Drake-Brockman is also reproduced in Wood's *Ophthalmic Operations,* Vol. II, p. 1313.

In the latter half of the sixteenth century Ambroise Paré illustrated an eye speculum (Pl. I, Fig. 2) which he employed to separate the eyelids for operative purposes. These lid elevators were nearly circular in form, having a break in the major axis of the circle on

one side and on the other side they were attached to a handle (Ambroise Paré, *Oeuvres Complètes,* 1582, p. 305), (Hirschberg in Graefe-Saemisch, 2nd ed. Vol. XIV, p. 189). An instrument similar to this is that of Millar (Pl. I, Fig. 6, a, b), illustrated in Bell's *Surgery,* 1787, Vol. III, p. 244, plate XXX. The manner of its employment in the operation of couching cataract is described on p. 418 as follows: "The assistant is now to raise the upper eyelid with the fingers of his left hand; and the surgeon applying the groove in the upper part of the speculum, in such a manner that it may receive the edge of the eyelid, the opening or circle formed by the brim of the speculum is to be pressed upon the ball of the eye, till the transparent cornea, and nearly about an eighth part of an inch of the sclerotica, is protruded; by which means if a steady and equal pressure be continued upon the eye, it will be kept firmly fixed without any injury being done to it, at the same time that a sufficient quantity of the ball will be left uncovered by the speculum for the purpose of the operation." With regard to the value of the speculum, he says on page 416, "It is of much importance to have the eye properly fixed during the whole course of the operation, and as this cannot be done effectually in any other manner than with a speculum exactly fitted to the eye, every operator should be provided with several sizes of this instrument;" and on p. 436 in the chapter on cataract extraction, "when the lens is to be extracted from the left eye, the speculum must be applied in the manner we have formerly mentioned, and must be pressed upon the eye with the left hand of the operator with as much firmness as is necessary for securing the eye; but more than this should be avoided, as it not only gives more pain, but is apt to press the cornea into too near contact with the iris; by which the latter is in great risk of being injured in the subsequent steps of the operation." For the explanation of the break in the ring he says, p. 438, on cataract extraction: "We are advised indeed by some to remove the speculum altogether on the knife being passed out at the opposite side of the eye; and for this purpose an opening is left on one side of the instrument, to admit of its being taken off." (Pl. I. Fig. 6, b.) "But with an operator accustomed to the use of the speculum, there is no necessity for this precaution; for a degree of pressure may be continued with it sufficient for fixing the eye, without any risk of forcing out the vitreous humor; and by keeping the eye fixed to the last, we are enabled to form the incision with more exactness than can possibly be done when the speculum is removed earlier in the operation."

By these quotations from Pare's work it will be seen that elliptical-

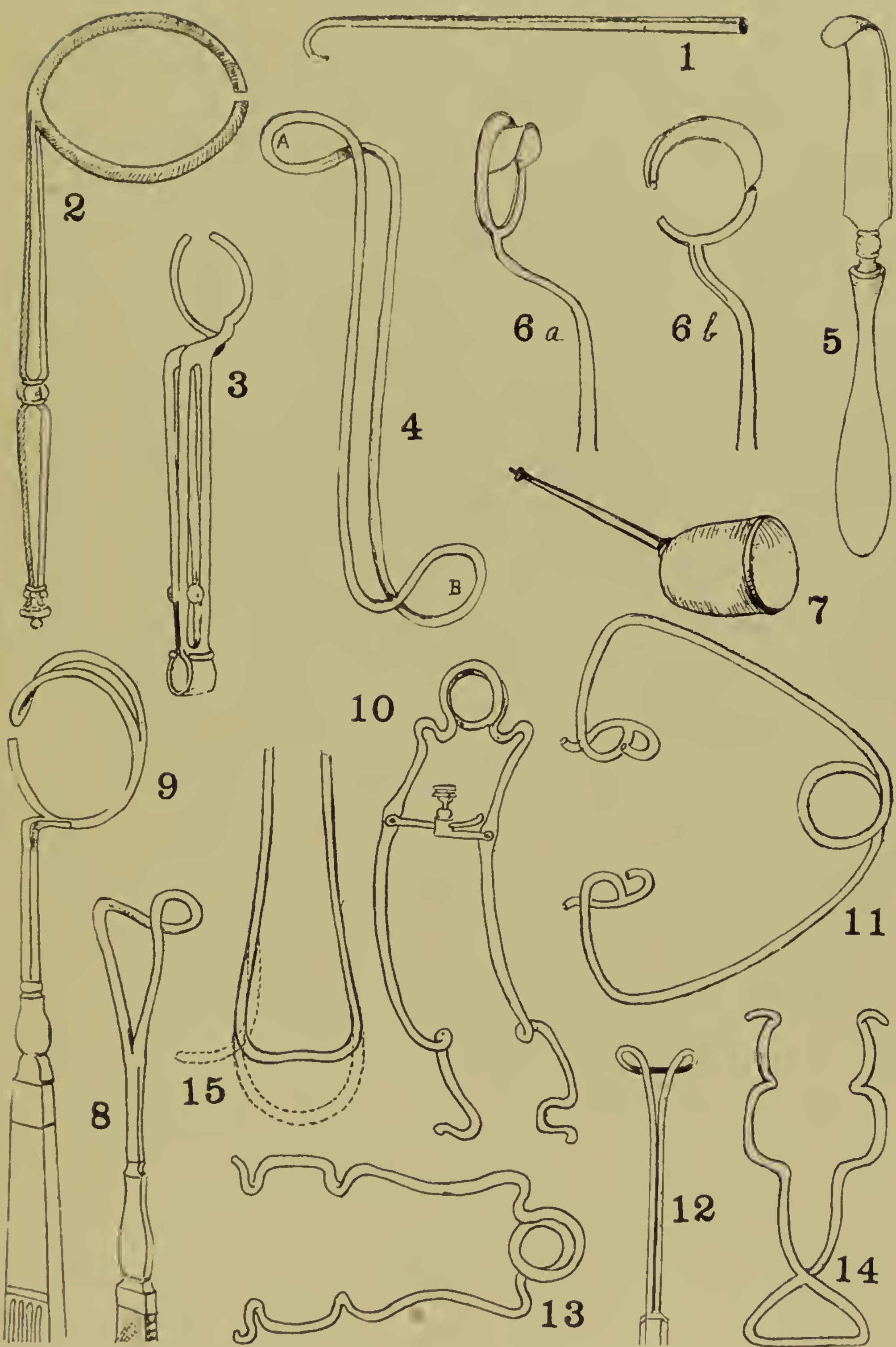


Plate I—Eye Specula. (Ewing.)

1. East Indian eyelid hook elevator.
2. Eye speculum of Ambroise Paré, 1582.
3. Eye speculum of Cheselden, 1727.
4. Eyelid elevator of Pellier, 1788.
5. Eyelid elevator of Bell, 1788.
6. a, b. Eye specula of Millar, 1788.
7. Eyelid thimble elevator of Rumpelt, 1805.
8. Eyelid elevator of Comperat, 1838.
9. Eye speculum of Lusardi, 1838.
10. Eye speculum of Kelley-Snowden, 1843 (?), 1874.
11. Eye speculum of Hayes, 1843.
12. Eyelid elevator of Walton, 1853.
13. Eye speculum of 1855.
14. Eye speculum of 1858.
15. Eyelid elevator of Saunders, showing the change made by him in the curve of the end of Pellier's elevator.

like and round specula were employed not merely for fixing the lids but also for fixing the globe at the same time. Also it must be kept in mind that anesthetics were then unknown.

A similar instrument is that of Lusardi (Pl. I, Fig. 9), illustrated by Carron du Villards, 1838, which has a projecting wire loop for holding the upper lid, instead of the continuous plate. One like this is described by Ware, 1805, Vol. I, p. 85, but credited to "Mr. Else." The blade for holding the upper lid being located on the circle at the end of these instruments, the opening being at the side as described by Bell, and the curve of the handles, indicate that they were operated from below.

In Fig. 12 of the plate contained in Vol. I, Ware illustrates the thimble elevator of Rumpelt (Pl. I, Fig. 7), which was worn on the middle finger of the operator, while the other fingers were left for controlling the lower lid and the globe. He does not describe but mentions specula invented by "Beranger, Guerin, Pope, Petit, Le Cat, and many others." A number are described in *Encyclopaedisches Wörterbuch der Medicinischen Wissenschaften*, 1843, Vol. IV, under the titles Augenhalter and Augenlidhalter.

In the chapters on the eye in his work on surgery, Bell mentions two other instruments of interest, one "a flat curved hook" (Pl. I, Fig. 5) for elevating inflamed upper lids to remove foreign bodies, while the lower lid is depressed by the fingers (Bell, *A System of Surgery*, Vol. III, p. 238, Pl. XXIX, 1788). This was also used in enucleation of the eye, one for the upper and one for the lower lid (ib. p. 388). This flat hook is the forerunner of Desmarres' lid elevator. The other, of special interest, is the curved wire elevator of Pellier (Pl. I, Fig. 4), (ib. Vol. IV, p. 21, Pl. XXXIX). His description of the instrument and of Pellier's manner of employing it in the extraction of cataract is as follows: "It is made of wire; and it may either be of gold, silver, or any other metal. The head being fixed by pressing it against the breast with one hand under the chin, the assistant takes this instrument in the other; and placing the round curvature A upon the upper eyelid immediately behind the tarsus or cartilage, he must by gentle gradual pressure fix the eye above, while the operator with the fore and middle fingers of his left hand, when the operation is to be done upon the left eye, must fix it below, at the same time that he draws down the under eyelid. In using this instrument the upper eyelid is forced almost entirely into the orbit, but it immediately returns to its natural situation on the instrument being withdrawn."

This instrument is the ordinary wire lid elevator of the present

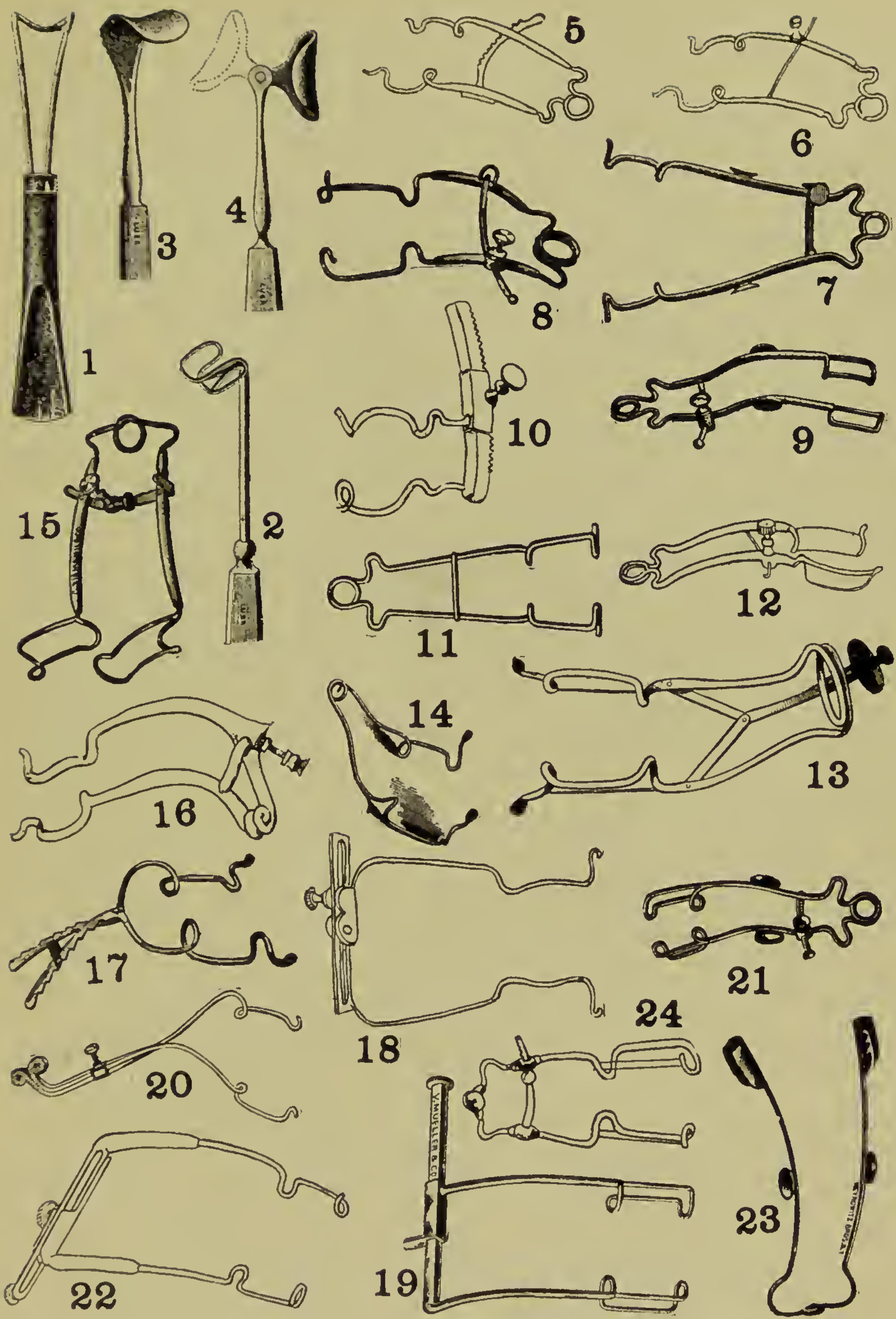


Plate II—Eye Specula. (Ewing.)

1. Eyelid elevator of Jaeger.
2. Eyelid elevator of Noyes (1).
3. Eyelid elevator of Desmarres.
4. Eyelid elevator of Abadie.
5. Eye speculum of Bowman, 1864.
6. Eye speculum of Bader, 1864.
7. Eye speculum of Graefe.
8. Eye speculum of Critchett.
9. Eye speculum of Weber.
10. Eye speculum of Noyes, nasal side (2), 1875.
11. Eye speculum of Noyes (3).
12. Eye speculum of Laurence, 1869.
13. Eye speculum of Noyes (4), 1869.
14. Eye speculum of Hart.
15. Eye speculum of Critchett, nasal side.
16. Eye speculum of Foveaux, 1869.
17. Eye speculum of Schwatka.
18. Eye speculum of Murdoch (1), 1874.
19. Eye speculum of Murdoch (2), 1883.
20. Eye speculum of Leibold.
21. Eye speculum of Hirschberg.
22. Eye speculum of Friedenwald, 1876.
23. Eye speculum of Stevens.
24. Eye speculum of Randolph.

day, which has the elevators at either end of the handle, one curved in the opposite direction from the other. Saunders, 1811, modified the hook by making a depression at the center of the curved portion corresponding to the center of the lid (Pl. I, Fig. 15). He also made the hook of one end smaller than that of the other in order to adapt the instrument to the eye of a child or of an adult. Later it was further modified by Jaeger by employing only one of the hooks on one end and his lid spatula on the other end of a handle. This is known as Jaeger's lid elevator, (Pl. II, Fig. 1). Carron du Villards, 1838, illustrates the lid elevator of Comperat, in which the change from the Pellier form consists in reuniting the ends of the wire after the hook has been formed and inserting them in a handle (Pl. I. Fig. 8), such as is used for knives, hooks and other eye instruments. The modern form (Pl. I, Fig. 12) is shown in Walton, Am. Ed., 1853, and in Mackenzie, 1854. Beer, 1817, Weller, 1823, and Tyrrell, 1840. each illustrates the Pellier elevator, but attributes it to Richter. Noyes, 1874, modified the hook blade by adding a second wire near the handle (Pl. II, Fig. 2) so as to firmly engage the tarsal margin of the lid and to tuck the lid back under the margin of the orbit in eyes that are deeply sunken. Hess has added a second blade parallel with the first so arranged that it will press against the principal blade for the purpose of holding oiled silk or gutta percha tissue (Pl. V, Fig. 1). Nicati omits the loop, employing only two separated hooks on the same handle (Pl. V, Fig. 2). Callan, Motais, Fage and Edgar Browne have arranged it for irrigating the conjunctival sac (Pl. V, Figs. 6, 12, 14, 15). Other modern forms of this instrument are those of Stevenson, Baxter, Moraweck and Fisher.

The flat curved continuous plate form of blade, Bell's "flat curved hook," was modernized by Desmarres to the form that bears his name (Pl. II, Fig. 3), which is still an ideal instrument. Abadie had the blade pivoted to the handle (Pl. II, Fig. 4) so the instrument could be operated from above or from the side (*Encyclopedie Française d'Ophtalmologie*, Vol. IX, p. 35). Ziegler has broadened the blade. Chibret has made it narrower, and it has been arranged by Lagrange. Terson and Wieden so as to be useful for irrigating the retrotarsal fold (Pl. V, Figs. 7, 11, 10, 13, 16).

In the employment of the preceding forms of instruments the lids are controlled by holding the instruments in the hand. An exception is the hook devised by Swanzy (Pl. VI, Fig. 8), which is unique in that the hook is attached to a chain and this chain is suspended from a band that is fixed to the forehead. The links of the chain catch on a pin that projects from the band and the hook is raised

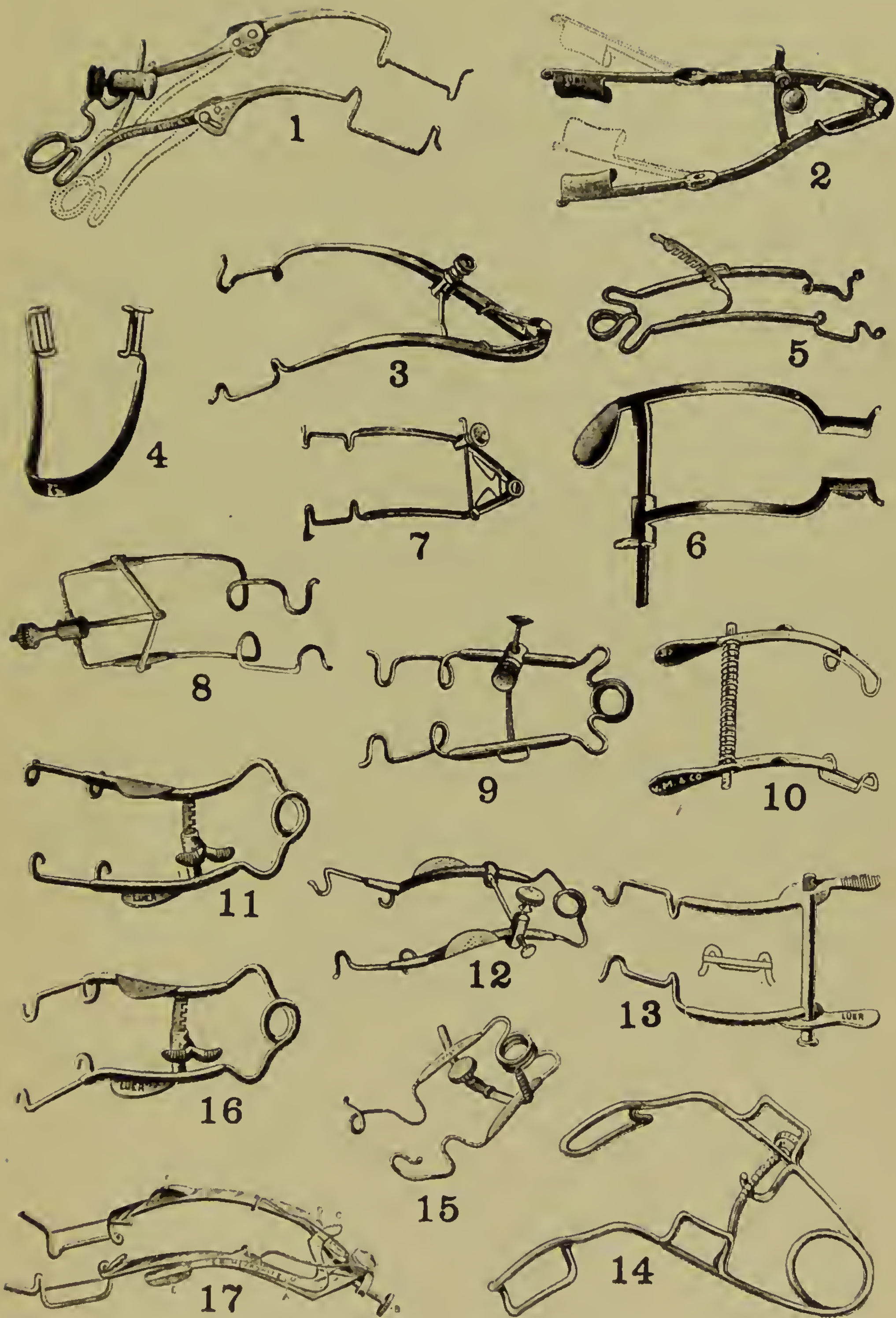


Plate III—Eye Specula. (Ewing.)

1. Eye speculum of Galezowski.
2. Eye speculum of Panas, 1894.
3. Eye speculum of Knapp.
4. Eye speculum of Greven.
5. Eye speculum of Schweigger.
6. Eye speculum of Monosmith.
7. Eye speculum of Fox.
8. Eye speculum of Galante.
9. Eye speculum of de Wecker.
10. Eye speculum of Mellinger (1).
11. Eye speculum of Landolt (2), 1885.
12. Eye speculum of Landolt (1).
13. Eye speculum of Mellinger (2).
14. Eye speculum of Koster.
15. Eye speculum of Liebreich.
16. Eye speculum of Landolt (3), nasal side.
17. Eye speculum of Skeel.

or lowered by means of the links (*Jour. Am. Med. Ass.,* November 16, 1907), (*Am. Encyclopedia of Ophthalmology,* Vol. III, p. 1658).

The first self-retaining speculum illustrated in the literature is that of Cheselden, 1727 (Pl. I, Fig. 3). Its blades are halves of a circle somewhat flattened on each side. The limbs of the handle are united by a spring and each limb contains a slot. A set screw or a traveling guard works in this slot connecting the limbs and permitting the blades to be opened and fixed at any desirable distance. This instrument was evidently widely employed, for in his criticism of it as compared with Millar's (Pl. I, Fig. 6, a, b) mentioned above, Bell says, Vol. 3, p. 428: "It has been commonly objected to the use of a speculum, that it does not secure the eye sufficiently; and that it always proves detrimental, by exciting inflammation over the eyeball. This observation, I believe, is very well founded with respect to the instrument in ordinary use, of which a delineation is given in Fig. 4, Pl. XXXI. But it does not apply to the other (that of Millar), which, when properly fitted to the size of the eye secures it exactly; and when finely polished, it is never productive of any inconvenience."

Although this is the prototype in a general way of the self-retaining speculum, many changes have taken place in its construction in order to adapt it to modern surgery. The present day type occurs in two distinct forms, one that is maintained in position by friction, and the other by a spring. The last (Pl. I, Fig. 11) is illustrated and the first is described in Isaac Hays' American edition of *Lawrence on the Eye,* 1843. p. 731, as follows: "When the assistant cannot be depended on, the lids may be separated by a speculum; and the best for this purpose we have seen is the elastic steel-wire speculum, represented in the accompanying figure. The two branches are to be pressed together, one end introduced under the upper and the other under the lower lid; the force of the spring then separates the lids. An instrument, which also answers, has been devised by Drs. P. B. Goddard and W. W. Ruschenberger. It is made of silver wire, somewhat similar in form to that just figured, but it is constructed in two separate pieces, to one of which is attached a cylinder, and to the other a rod which slides in the former. When this instrument is applied, and the branches separated, the friction of the rod against the cylinder will effectually resist any effort of the patient to close the lids."

Another spring speculum of this date is pictured in Bernard and Huette, *Médicine Operatoire Atlas,* Pl. 40, Fig. 4, 1853-4, as it was employed in the eye for the operation of strabismus. It is called a ble-

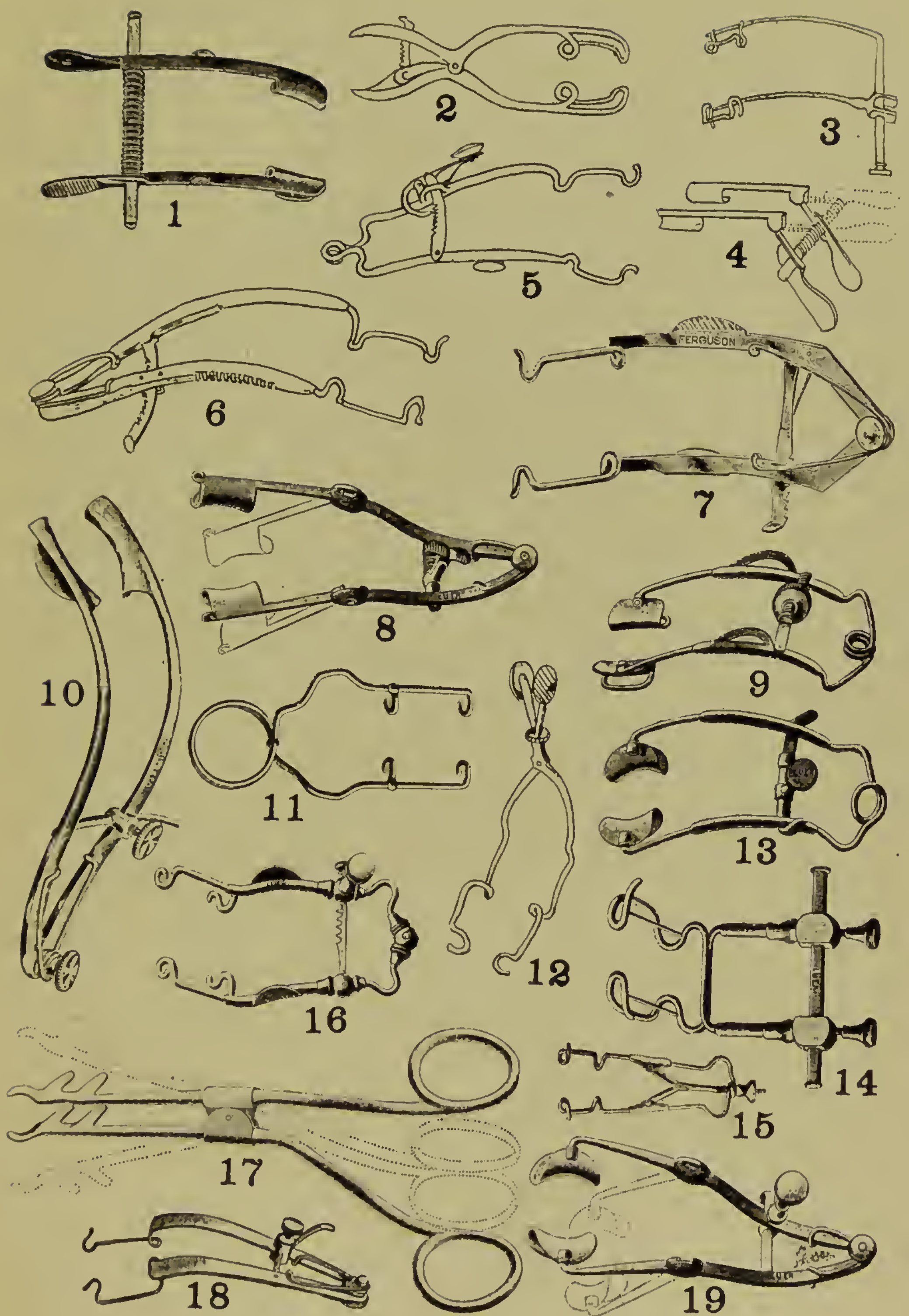


Plate IV—Eye Specula. (Ewing.)

1. Eye speculum of Beard, 1905.
2. Eye speculum of Schmidt-Rimpler (1), 1889.
3. Eye speculum of Schmidt-Rimpler (2).
4. Eye speculum of Stevenson, 1904.
5. Eye speculum of Schwarz.
6. Eye speculum of Bishop, 1906.
7. Eye speculum of Shoemaker, 1909.
8. Eye speculum of Menacho, 1886.
9. Eye speculum of Pley, 1907.
10. Eye speculum of Lang.
11. Eye speculum of Nicati.
12. Eye speculum of Mittendorf, 1902.
13. Eye speculum of Vacher.
14. Eye speculum of Coppez.
15. Eye speculum of Bowman.
16. Eye speculum of Duboys.
17. Eye speculum of Pedrazzoli. 1902.
18. Eye speculum of Payne.
19. Eye speculum of Gaupillat.

pharectome; but the design indicates that its only purpose was to separate the lids for operative procedures.

The pure types of these forms in common use at the present time are the plain spring speculum (Pl. I, Fig. 13), which was employed by Critchett in 1855 (Hirschberg, in Graefe-Saemisch, Vol. XIV, abth. IV, S. 189), and the well known friction, or bar and canula speculum of Murdoch (Pl. II, Fig. 19) (*Trans. Am. Ophth. Socy.*, 1883, p. 467). From these two types a great number of combinations have arisen, with a variety of ratchets, set-screws, rings, loops and triggers to aid in the ease of introduction and in the rapidity of removal. The most common form of the spring types is a continuous spring with a crossbar and a set-screw attachment; or a form in which the arms of the elevators are united by a pivot and opened by a small spring in the angle, the action of the spring being under the control of a crossbar and a set-screw. (See accompanying plates.)

An addition to the friction, or bar and canula form of the speculum, is the placing of a coil spring about the bar to aid in introducing the instrument (Pl. III, Fig. 10), and another change is in having in one of the bars a slot, in which a set-screw on the fellow bar plays, thus permitting the opening or the closing of the instrument and the fixing of the bars at any point. These forms are illustrated, the one (Pl. II, Fig. 18) by Dr. Murdoch (*Trans. Am. Oph. Soc.*, 1874, p. 211), and the other (Pl. II, Fig. 22) was an invention of Dr. Aaron Friedenwald about forty years ago, but never described by him. It is the only form Ewing has been able to find that actually drops apart on the release of the set-screw, so that one blade may be removed without disturbing the fellow blade. Green has added a handle to the second Murdoch speculum in order that it may be operated by an assistant (*Ophthalmic Record* ,Vol. XXIV, p. 67), (Pl. VI, Fig. 10).

As a rule surgeons prefer to operate the speculum from the temporal side, but some prefer to employ it from the nasal side, and many specula are arranged for insertion from the nasal side.

There is a great variation in the size and shape of the arms that support the blades, some being thick and heavy, others thin and light, and they may be round, square or flat. The speculum of Panas (1894), (Pl. III, Fig. 1) shows a knee-joint-like arrangement near the center of the arms for accommodating the instrument to the outer orbital margin. In 1904 Stevenson devised a similar arrangement for the Mellinger speculum (*Ophthalmic Record,* April, 1904), (Pl. IV, Fig. 4).

While blades have in common practically the same curve, they vary

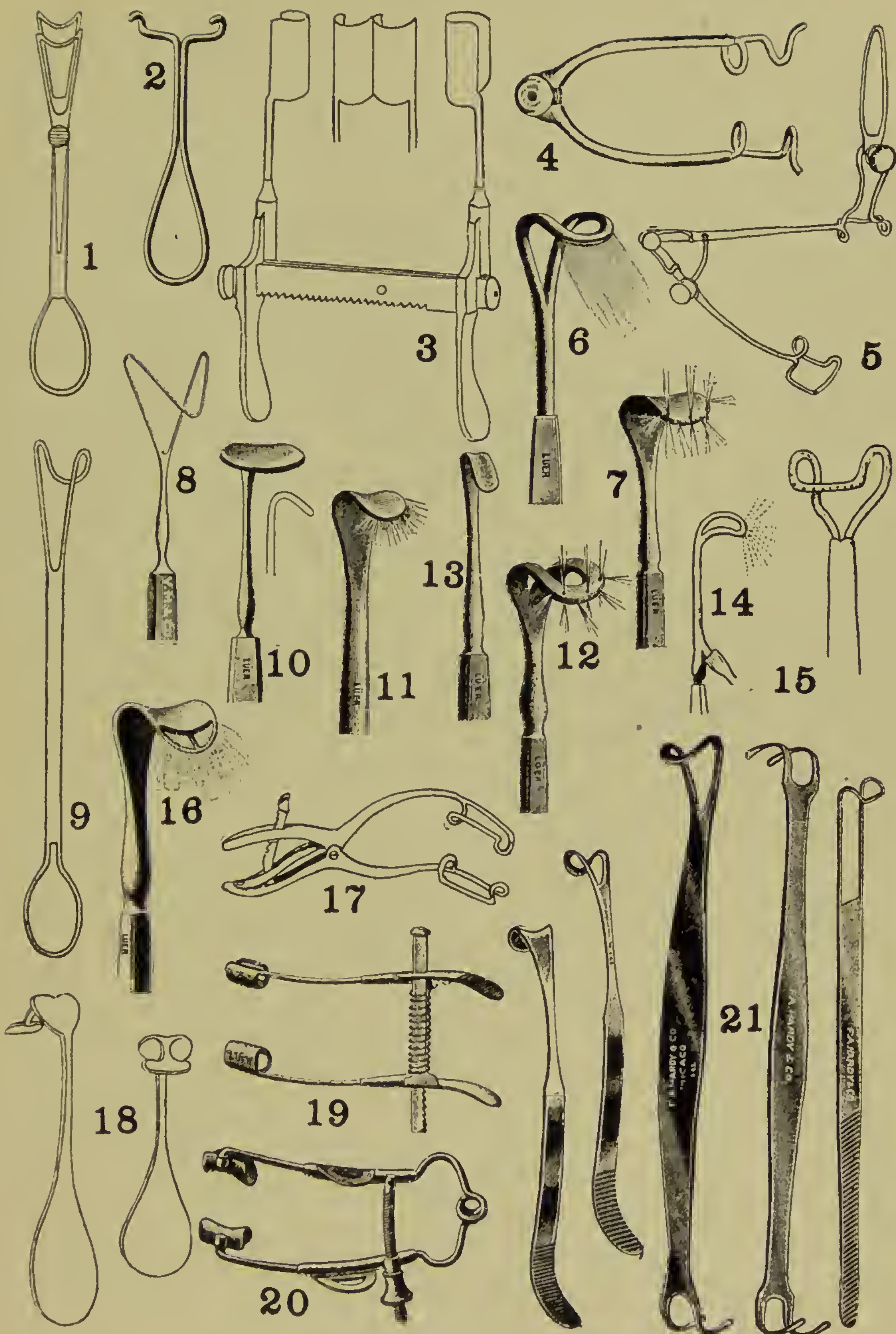


Plate V—Eye Specula. (Ewing.)

1. Eyelid elevator of Hess.
2. Eyelid elevator of Nicati.
3. Eye speculum of Mueller, 1905.
4. Eye speculum with concealed spring.
5. Eye speculum of Zimmermann, 1911.
6. Eyelid elevator of Fage.
7. Eyelid elevator of Lagrange.
8. Eyelid elevator of Stevenson.
9. Eyelid elevator of Moraweck.
10. Eyelid elevator of Ziegler.
11. Eyelid elevator of Terson.
12. Eyelid elevator of Motais.
13. Eyelid elevator of Chibret (for infants).
14. Eyelid elevator of Callan.
15. Eyelid elevator of Edgar Browne
16. Eyelid elevator of Wieden.
17. Eye speculum of Chisholm.
18. Eyelid elevators of Vail, 1915.
19. Eye speculum of Morax.
20. Eye speculum of Torson
21. Eyelid elevators, 5, of Fisher, 1914.

in that some consist of two hooks, as those of Landolt and Nicati, which are new forms of the elevator employed by Daviel (*Encyclopädisches Wörterbuch der Medicinischen Wissenschaften,* Vol. IV, p. 227); some consist of the curved wire loop, as that of Pellier and most modern specula; some have the fenestrated form, which is the wire loop with a second wire bridging the opening for the purpose of engaging the cilia, and some consist of a continuous curved plate of metal or horn, as that of Desmarres. Laurence seems to have been the first to adapt this plate to the modern form of the self-retaining spring speculum (Laurence, *A Handy Book of Ophthalmic Surgery*, p. 39). The advantages claimed for this form of blade are that it engages the lashes and protects the wound against the secretions from the lid margin. Beard prefers to have the hook of the plate shorter than most operators, to avoid irritating the retrotarsal fold. Koster employs the fenestrated form and gradually widens the hook to the temporal side. This aids in keeping the lids widely separated at the outer angle. In some specula the blade is attached to the arm by a pivot in such a way that it will have a swivel action. In the speculum devised by him, Landolt arranged the hooks of the one blade so they will pass the hooks of the other when the instrument is closed, the purpose being to aid in the ease of its introduction between the lids (*Archives d' Ophtalmologie*, Vol. V, p. 53). Mueller has adjusted the blades so they will automatically rotate from beneath the lids as the speculum is withdrawn (Pl. V, Fig. 3). (*Klin. Monats. für Augenheilk.*, Vol. XLIII, pt. 2, p. 266). For the purpose of securing better antisepsis a second blade to clamp a bit of sterilized fabric to the principal blade has been added by Emanuel (Pl. VI, Fig. 9), (*Klin. Monatsb. für Augenheilk.*, Vol. XLV, p. 567). A recent innovation is the construction of the blades from small tubing, in which are minute openings for irrigating the conjunctival sac while the speculum is in position.

The great number of instruments for holding the lids apart for operative procedures illustrated in the accompanying plates is the evidence that the ideal lid elevator has not yet been discovered. Previous to the introduction of the local anesthetics, especially cocaine, the control and release of the lids was of the greatest importance in nervous and unruly patients, and up to that date most of the books show the lids held by fingers for such hazardous operations as cataract. For other operations, as for pterygium and strabismus, the speculum was employed. Since the relieving of the tension of the patient by means of an anesthetic to the lids nearly all the books show the lids held apart by some form of self-retaining speculum in operations requiring the separation of the lids.

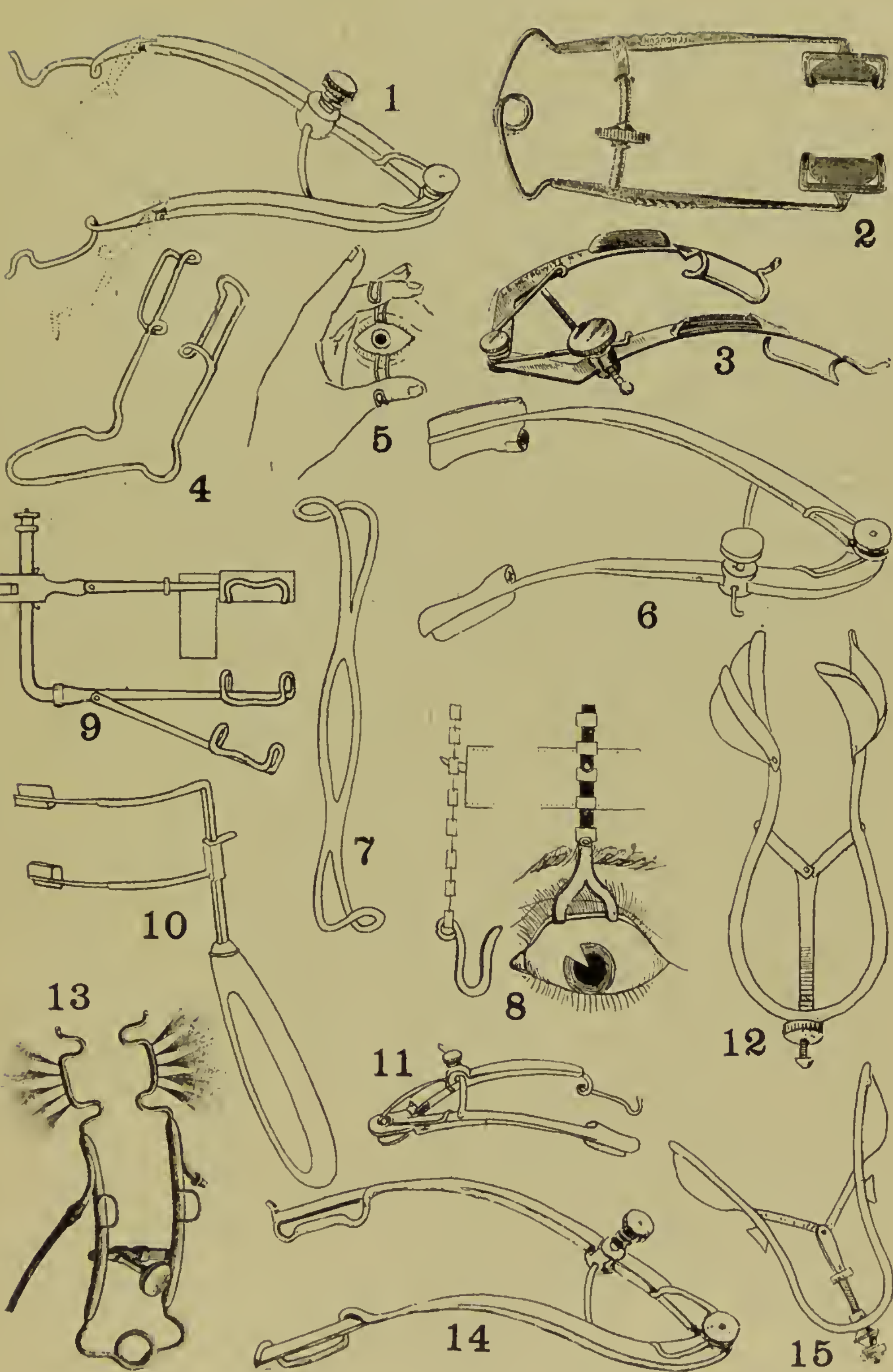


Plate VI—Eye Specula. (Ewing.)

1. Eye speculum of Webster Fox.
2. Eye speculum of Ziegler.
3. Eye speculum of Weeks.
4. Eye speculum of Greene.
5. Eyelid elevators of McGillvray.
6. Eye speculum of Lang (for redundant upper lids).
7. Eyelid elevator of Rowan.
8. Eyelid elevator of Swazey, 1907.
9. Eye speculum of Emanuel, 1906.
10. Eye speculum of Green, 1915.
11. Eye speculum of Stroschein.
12. Eye speculum of Beebe.
13. Eye speculum, irrigating.
14. Eye speculum of Williams.
15. Eye speculum of Wild.

The bar types are objectionable to the writer because of the difficulty of their introduction as well as removal, and the spring types because of the necessity of pulling down the lower lid or raising the upper lid in order to remove them. For a number of years Ewing has relied mainly on the fingers of an expert assistant for all dangerous operations on the globe. Lately this expert help failed him and this prompted the invention of the following three designs of specula, or rather the first design led to the second and the second to the third in the order of their description.

In the first design, the plan was to manipulate the elevators from a thin metal plate, or a large aluminum wire (a) standard gauge 30, flattened on the side next to the face and curved in the form shown in Pl. VII, Fig. A. To each end was riveted a carrier containing a groove (c) and set-screw (d). The handles (h) of the elevators (e) were placed at right angles to the arms of the elevator and were constructed so as to glide snugly but freely in the grooves of the carriers. The set-screws were arranged to clamp the handles toward the front in order that the handles might be made to move easily in the grooves when not firmly fixed by the set-screws, as this aided both in adjusting the blades and also in sterilizing the instrument. The aluminum wire was fastened to the temple of the patient by adhesive plaster, or held by a nurse or an assistant, and the elevators were then adjusted to the eye. This instrument was employed in several cataract operations successfully but not satisfactorily, because of the inability to introduce the two blades at the same time. To obviate this defect the design in Plate VII, Fig. B, was devised. This consists of a combination of the spring and friction types of specula. It is constructed by hinging a spring (s) to the carriers represented in Fig. A. One of the carriers is then fixed to one end of a bar (b), the other end of which is arranged to glide freely but snugly through a tube or canula in the fellow carrier. Very near the carriers, hand-holds (h) are placed in the ends of the spring. When the elevators are fixed in position by the set-screws as widely apart as may be required they may be brought together by moderate pressure on the spring at the hand-holds. After introduction between the eyelids the spring is released and the speculum is in place. Its removal may be effected in two ways. The blades may instantly be brought together by pressure on the spring at the hand-holds near the bar, and the removal effected in the usual manner, or the set screw of the upper lid blade may be released and this blade may be easily slipped from beneath the lid, and at the same time it may be kept away from the wound by lifting the lid a little forward with it as it is withdrawn. This last is the method preferred by the inventor.

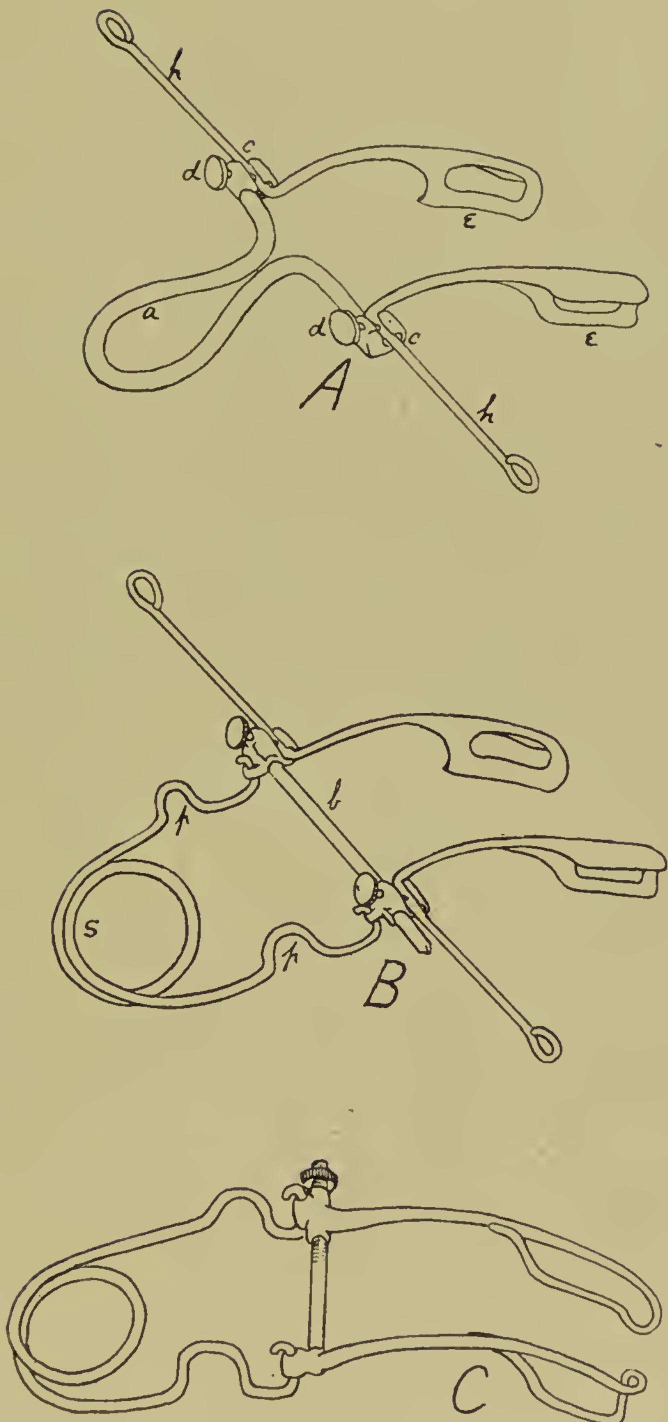


Plate VII—Eye Specula: Three New Designs. (Ewing.)

Fig. A. Eye speculum to be held on temple by adhesive plaster, arms of the blades controlled by set-screws.

Fig. B. Eye speculum: spring and friction types combined; arms of the blades controlled by set-screws.

Fig. C. Eye speculum: spring and friction types combined.

In the third design (Pl. VII, C), the handles, set-screws and grooves are omitted, and the arms bearing the blades are connected directly to the spring by the hinge. The instrument is inserted and removed in the same manner as any other spring speculum. At the suggestion of W. A. Shoemaker Ewing added a check in the form of a nut to the free end of the bar in this design to control the width to which the arms may open. If the spring is weak, as it should be, this is an unnecessary addition, but it is a protection in the case of a strong spring. It is an excellent instrument for all operations, but for cataract operations, or for any operation in which the globe is to be incised to any extent, the inventor prefers the one just preceding. The action of each of these last two instruments is the same as in the Mellinger or the Beard speculum, but there is no coil spring to become stiff as the instrument is closed or to prevent the near approach of the blades in closing it.

Either of the three designs may be constructed wholly of German silver. For the spring standard gauge 56, for the arms 51, for the cross bar 49, German silver wire is employed, and the blades are of sheet German silver 1/32 of an inch in thickness. The weight of B is 156 grains and that of C is 73 grains. The width of the blade which passes beneath the lid is 12 mm., but it gradually increases in width to the temporal side to 22 mm. at its attachment to the arm. The depth of the groove is 5 mm., its width is 4.5 mm. The length of the arm and the blade combined is 37 mm. The length of the spring when the blades are closed is 38 mm., the size of the coil is 20 mm. The hand hold is 6 mm. in height and 9 mm. wide at the base. The carrier is 5.5 mm. wide, 3 mm. thick and 6 mm. long; this does not include the small projections for the set-screw and for the hinge, both of which should be made as small and as light as possible. The blades are moderately curved to accommodate the curve of the lid margin. Any form of blade may be employed with either of the designs, but the one from the above measurements, which is represented in designs A and B, has given the greatest satisfaction to the inventor.

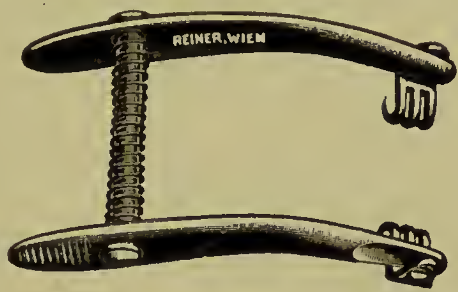
Descriptions and cuts of other eye specula.

So far as possible the figures in this text are taken from the original drawings in the older works on ophthalmology. The modern forms have been taken from instrument catalogues. Descriptions of the instruments have been omitted because the mechanism is much more readily comprehended by investigating the diagrams.

In addition to the foregoing a few of the rarer forms of specula used in eye operations as well as some that call for special illustration or description are here referred to in alphabetical order.

Axenfeld's lachrymal sac (retractor) speculum. A view of a different model of this instrument (see cut in this text) is given on page 6964, Vol. IX of this *Encyclopedia.*

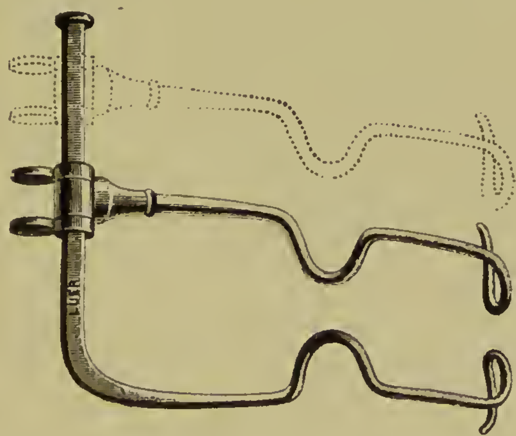
Brailey's eye, or "fixation" speculum was designed to obviate the difficulty which is experienced in fixing the eye in various operations, such as removing a cataract or performing an iridectomy. Even if an assistant is employed, the ordinary fixation forceps frequently



Axenfeld's Lachrymal Sac (Retractor) Speculum.

cut out. The fixation speculum consists of a speculum of the pattern most favored by the surgeon with the addition of two arms on the lower blade, each bearing two rounded spikes.

To insert this, the upper blade is first put into place under the lid, and then the points on the lower blade are pressed against the con-



Coppez's Speculum.

junctiva, just external to the corneo-scleral junction, about 3 mm., from the lowest part of the cornea; next the blade is put into position behind the lower lid, so rotating the eye down and holding it there, leaving the hands of the surgeon free for the operation.

To remove it the upper blade is taken out first. See p. 5215, Vol. VII of this *Encyclopedia* for illustration.

Coppez's eye speculum is depicted in this text. The arms are so arranged that they are constantly parallel.

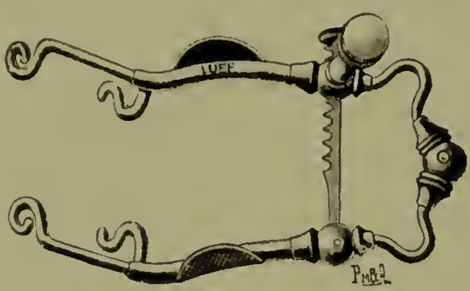
Coulter's eye speculum. See *Pley's eye speculum* in this section.

E. R. Crossley (*Journ. Am. Med. Assocn.*, p. 2103, Dec. 22, 1917) has invented an apparatus that combines an eye speculum with a device for the prevention of "squeezing." The inventor believes that with this head clamp and eyelid retractor, the operator can go to his operation with a feeling that no accident is going to occur to detract from his good results, and that he can positively assure his patient that he cannot move and injure himself during the operation.

This reassures his mind and inspires confidence in the operator, obtaining a perfect control of the situation that is impossible to obtain otherwise.

The apparatus consists of two parts, the base and superstructure or framework carrying the lid hooks.

The base consists of a rectangular wooden block 12 by 22 inches, lengthwise through which is a long screw on which are mounted two



Speculum of Duboys de Lavigerie.

strong metal uprights, one of which is stationary, and the other movable. Attached to these are large pads, which grasp the sides of the head as the one approaches the other. The superstructure is a metallic frame which attaches easily to the uprights. On the crossbars of this structure are mounted two sliding locks, for fixing the lid hooks after the lids have been retracted.

Between the two uprights is placed a circular pad which serves as a comfortable head rest. The length of the base is 22 inches, the average width of surgical tables. By means of clamps, the apparatus is fixed firmly to the table on which the patient lies.

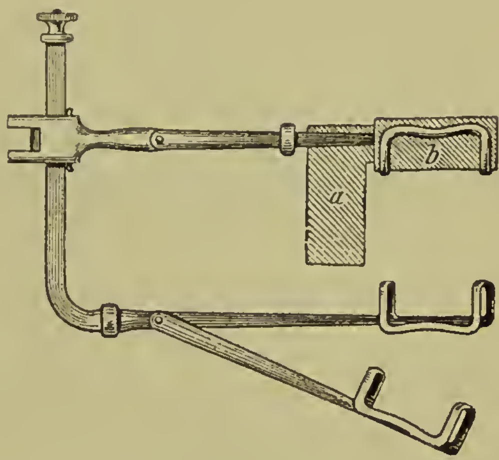
Duboys de Lavigerie's eye speculum is shown in this text.

Emanuel's speculum. The instrument may be used for either eye, and is automatically fixed or locked by the pressure of the lids. See the illustrations. The branches of the speculum are made double. The advantages claimed by this form of instrument are set forth in the *Klin. Monatsbl. f. Augenheilk.*, 1907, p. 567.

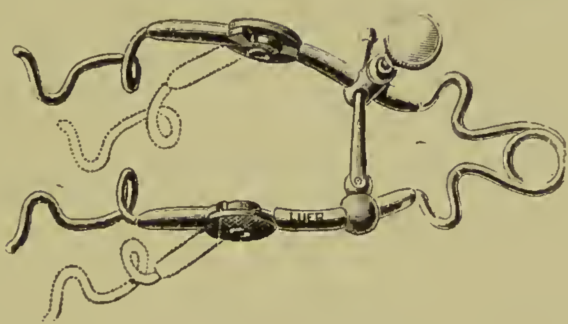
Ewing's eye speculum is fully described above in this text.

Galezowski's speculum has movable arms, as shown in the accompanying figure.

Emanuel's Automatic Lid Speculum.
Side view.

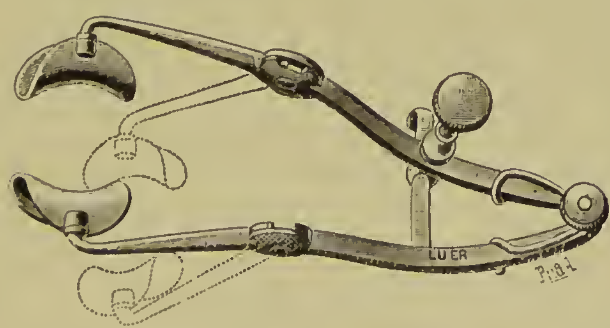


Emanuel's Speculum.
Front view.



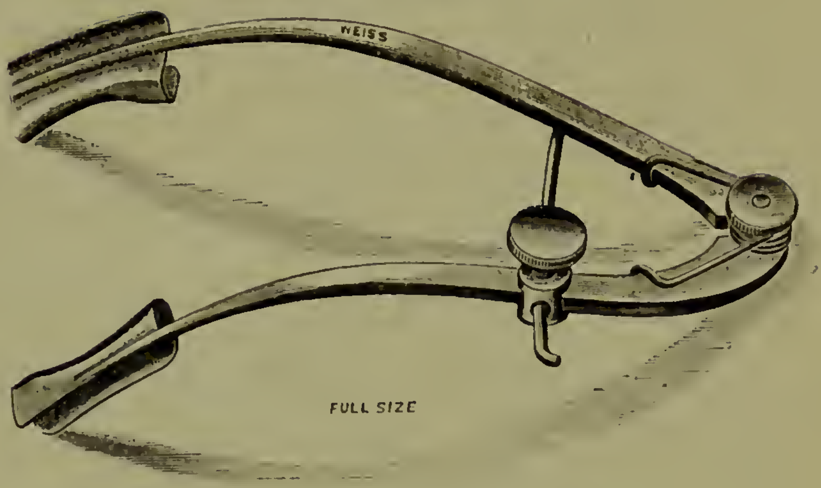
Galezowski's Speculum.

Gaupillat's speculum also has movable branches. See figure.



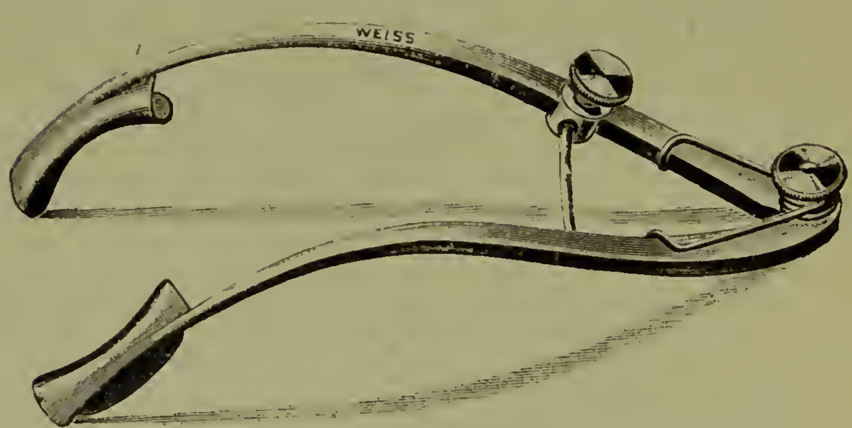
Gaupillat's Speculum.

Lang's eye speculum. One form has detachable (the other solid) arms, a guard on the upper blade for loose, overhanging lids and for keeping the lashes away from the field of operation. See, as illustrated, right and left instruments.



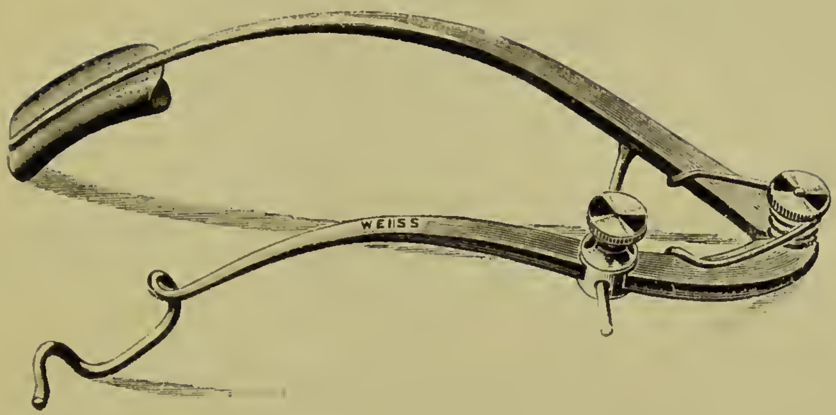
Lang's Eye Speculum.

Guard on the upper blade for loose, overhanging lids, and to keep lashes from the field of operation.



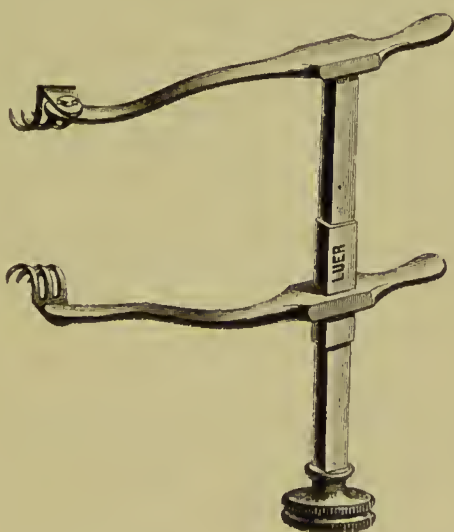
Lang's Eye Speculum, with solid blades, for keeping eye lashes away from the field of operation.

Lawford's eye speculum has a guard on the upper blade only and is made for right and left eye.



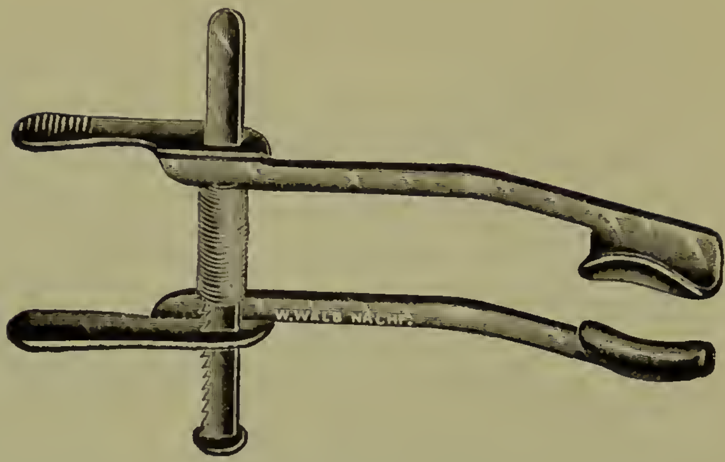
Lawford's Eye Speculum, with guard on upper blade only.

Luer's lachrymal speculum has removable arms.



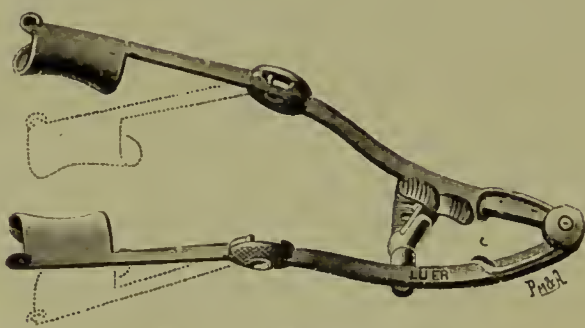
Luer's Lachrymal Sac Speculum with Removable Arms.

Mellinger's speculum. Two views are given of this popular speculum (which may be inserted *over the nose*), already described in this *Encyclopedia.*



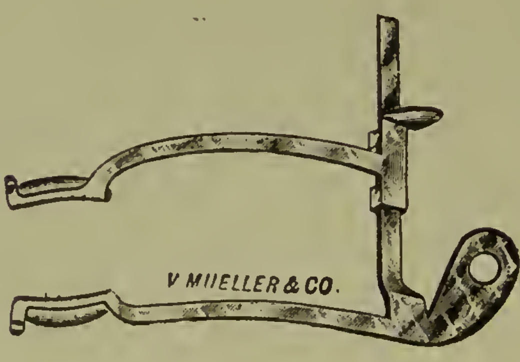
Mellinger's Speculum.

Menacho's speculum, with movable arm, is depicted in the text.



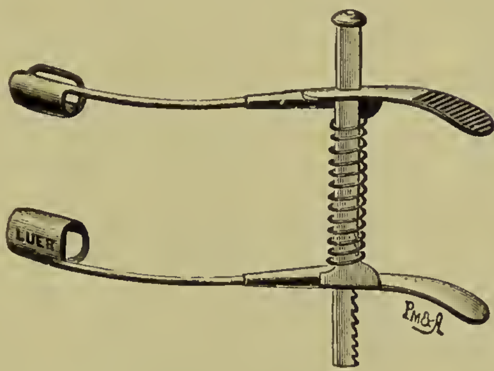
Menacho's Speculum.

Monosmith's eye speculum. See the figure.



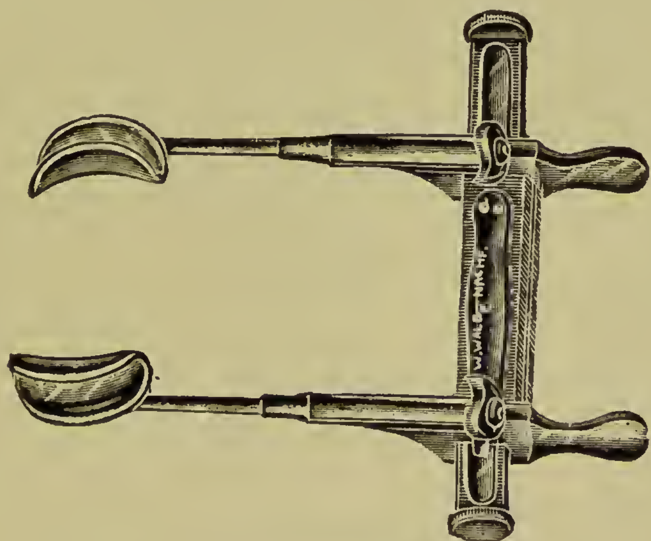
Monosmith's Eye Speculum.

Morax's speculum has fixed branches that in every position of insertion remain parallel.



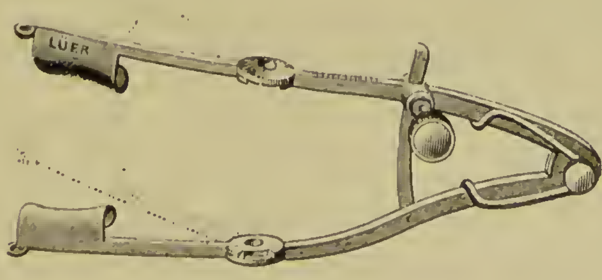
Morax's Speculum.

Müller's speculum is of rather complicated structure, but mainly with the purpose of preventing squeezing on the part of the patient. See the figure.



Müller's Speculum.

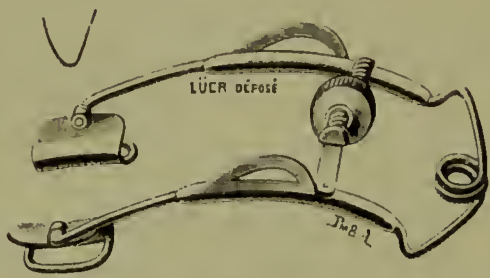
Panas' speculum has adjustable arms as shown in the illustration.



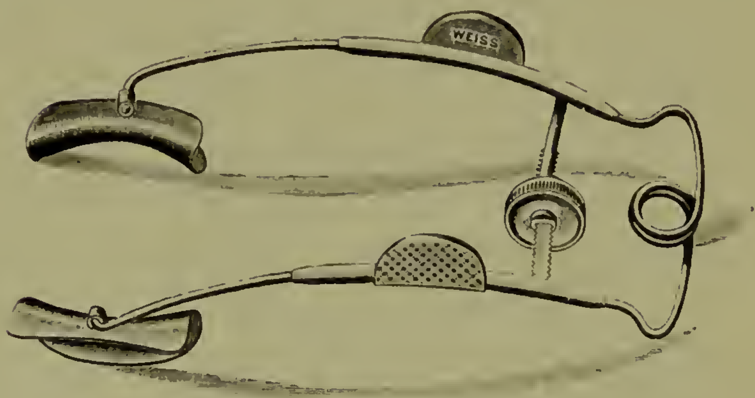
Panas' Speculum.

Pley's eye speculum, made by Luer, with swivel blades and screw adjustment is intended to remove pressure from the eyeball during operation; the movable arms allow of adjustment to any orbit, face or temple; it may be used right or left, and the patient cannot "squeeze" the lids.

A second figure shows the same instrument as modified by Coulter.

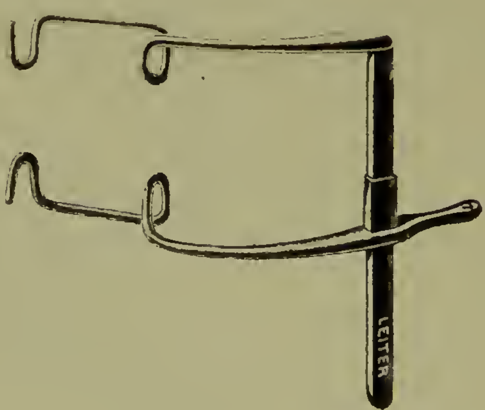


Pley's Eye Speculum.



Pley's (modified by Coulter) Eye Speculum, with swivel blades and screw adjustment.

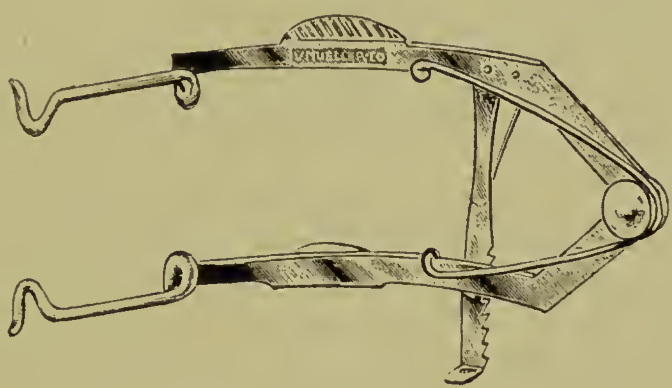
Pretori's lid speculum is depicted in this text.



Pretori's Lid Speculum.

W. T. Shoemaker's eye speculum is light in weight and short longitudinally, thus bringing its center of gravity nearer to the eye, and reducing materially the tendency which many of the longer and heavier speculums have of displacing themselves by their own weight and leverage.

The blades when in use are parallel and not divergent. This permits of an even and uniform exposure.

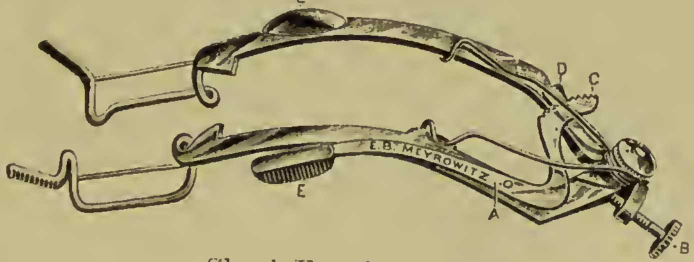


Shoemaker's Eye Speculum.

It can be operated with one hand and has a quick release, two points impossible with any speculum having a set screw.

The tension can be changed at any time to suit the needs of the case and the operator.

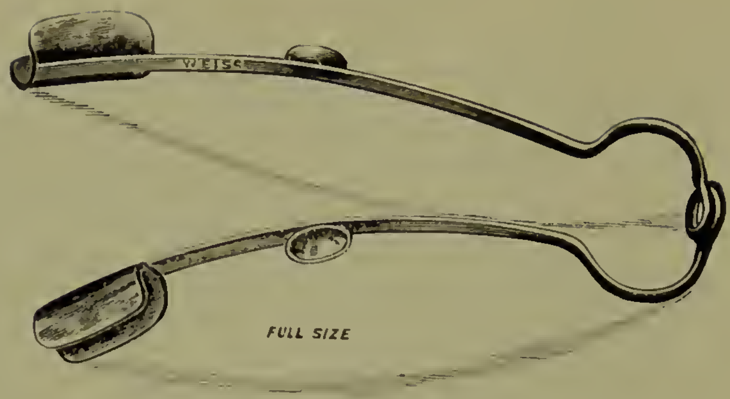
It is made with solid blades or with wire blades and of steel or German silver, the latter material being necessary if the speculum is to be used in magnet operations. See the figure.



Skeel Eye Speculum.

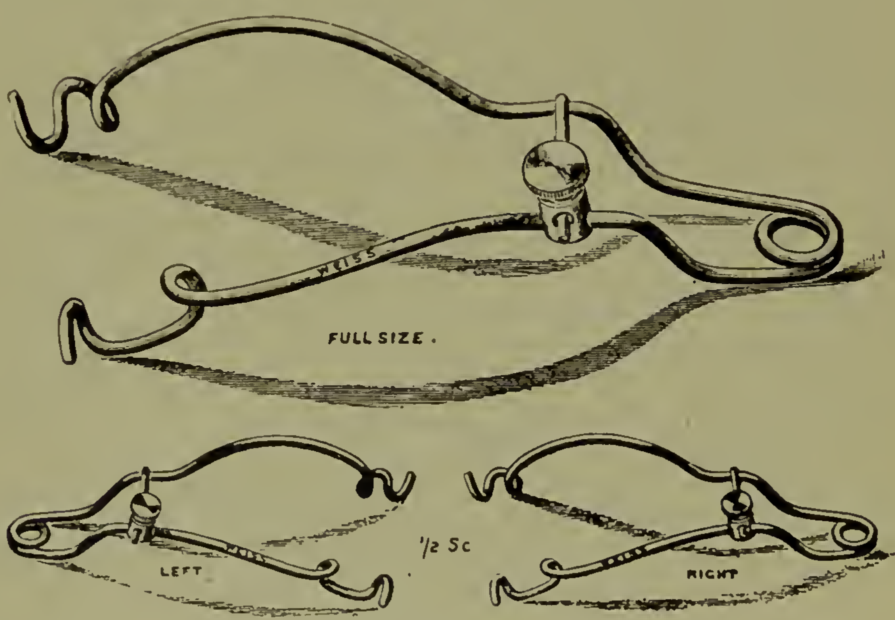
The *Skeel eye speculum* is among the more elaborate blepharostats but is intended mainly to keep the lids from pressing on the eyeball during the operation on the latter. See the illustration.

Stevens' eye speculum has, as shown in the cut, a simple spring and is fitted with blades of tortoise-shell.



Stevens' Eye Speculum, with spring and tortoise-shell blades.

F. W. Sumner's (*Ophthalm. Review,* April, 1913) speculum is intended to be used in the Smith-Indian cataract operation without skilled assistance "and making it impossible for the most nervous patient either to move his head or squeeze his eyelids."



Sumner's Cataract Speculum. (Weiss.)

The handle of the speculum has a curve to accommodate the index finger; the ball of the thumb rests on the spring: the portion of the upper blade which slips under the eyelid is narrower and projects under the lid much farther than in the orthodox instrument.

For the corneal incision it is introduced and used as an ordinary

speculum, except that the outer edge of the upper eyelid must be held back with a blunt hook to prevent the possibility of the knife touching and being fouled by it.

A different speculum is required for each eye, and a smaller speculum for use with very small or children's eyes. They are all of the same pattern.

The assistant holds the speculum between the index finger and thumb, taking a firm grasp of it: the other fingers lie against the side of the face: pressure of the thumb on the spring end of the speculum, acting through the index finger as a fulcrum, tilts up the eyelids to whatever extent is necessary.

The assistant's other hand is spread out over the patient's head and, the eyebrow having been well drawn back, his thumb presses against the upper edge of the orbit.

By flexing or extending the wrist the upper blade may be made to slide under whatever portion of the upper lid most exposure is necessary, according to the direction the patient rolls his eye.

By pronating or supinating the forearm the proper degree of "lift" of the eyelids off the eyeball can be obtained; the correct amount of the upper lid gives enough room to clearly see the fornix so that the patient may not roll his cornea out of sight: the lower lid is to be held just off the eyeball: with a bad squeezer the lids should be held well off the eye.

The assistant stands at the side, resting his elbows on the pillow on which the patient's head lies: there is no strain in the position of his body, arms or hands.

The operator stands at the top of the table bending over the patient's eye: the patient's head should lie on a very flat pillow and the top of his head be flush with the top end of the table.

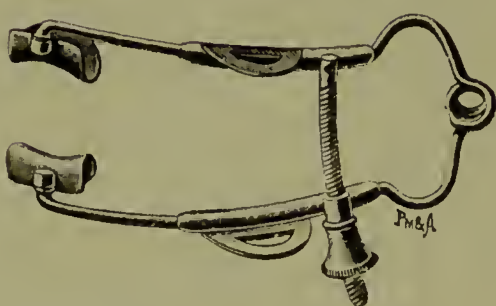
When the speculum is introduced the proper amount of separation of the blades (and of course of the lids) is found by raising the lids off the eye and then screwing down the pin to fix them: this amount of separation is generally less than the possible amount of separation of the blades when resting on the eye, the eyelids not being raised.

Terrien's lachrymal sac speculum is a modification of Müller's (q. v.). See the figure.

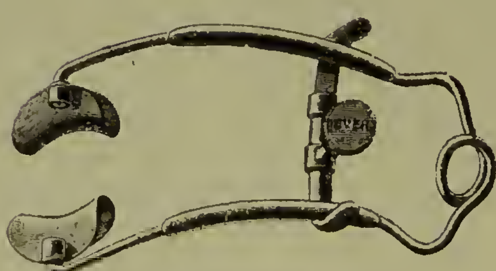
Terson's speculum has guarded arms, and is operated by a set-screw. See the illustration.

Vacher's speculum has movable arms. See the cut.

Terrien's Lachrymal Sac Speculum.

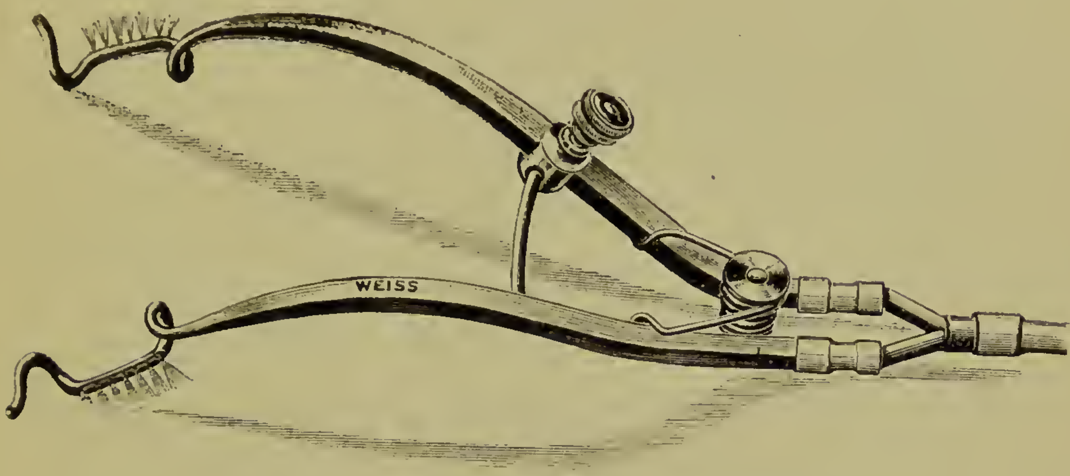


Terson's Eye Speculum.



Vacher's Speculum.

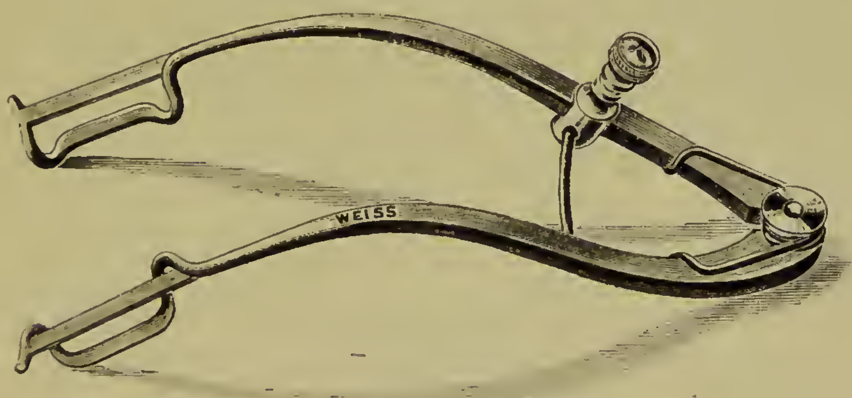
One of the *Weiss eye specula* is shown in the text combined with an eye douche.



Weiss' Eye Speculum, combined with douche.

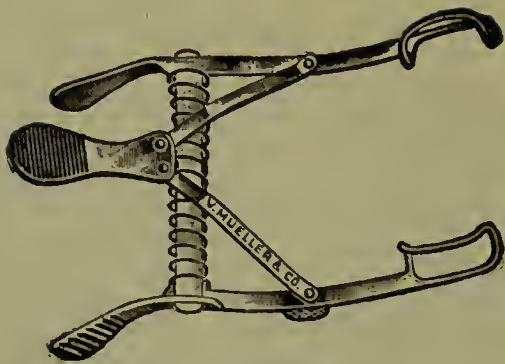
Weeks' eye speculum (*Text-Book*, p. 835) is light, strong, does not press or drag on the eyeball, tends to raise the lids away from the globe and the catch, screw and spring are easy of manipulation.

Williams' eye speculum. This useful instrument is shown in the text.



Williams' Eye Speculum, with lash-guard.

W. H. Wilder (*Ophthal. Record*, July, 1916) has had the ordinary eye speculum modified for cataract operation. To the under surface of the arms of the speculum are attached the ends of two rather firm bars, the other ends of which are fastened to a small plate that serves as a handle. These attachments are all jointed so that they do not interfere with the ready opening or closing of the instrument. The purpose of the contrivance is to furnish a small, firm handle, by means of which the assistant can at all times until the termination of the extraction easily and firmly lift the speculum away from the eyeball,

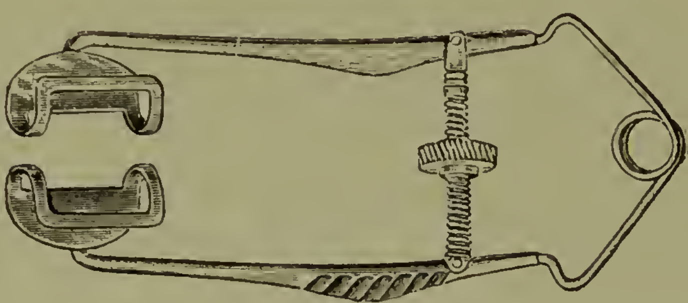


Wilder's Eye Speculum.

and yet have his hand away from the arms of the instrument should the operator suddenly be required to remove it. One may thus more readily guard against a sudden closure of the lids that might result in loss of vitreous.

The bars that form the handle are not so stiff that they cannot be slightly bent if desired, to conform to the shape of the face of the patient. Such a handle could be attached to almost any model of speculum.

Ziegler's eye speculum is provided with both lashes and lid guard and is adjusted by means of a set-screw. See the illustration.



Ziegler's Eye Speculum.

Speculum, Lid. See **Speculum, Eye,** as well as **Lid speculum,** and **Lid retractor.**

Speculum, Stop-. An eye speculum with an appliance for controlling the degree to which its branches spread.

Speech, Echo. Speech produced in the hypnotic state by pressure on the neck, abdomen, or right eye-brow, or speaking into the mouth.

Speech, Scanning. Speech in which the syllables are separated by prolonged pauses.

Speech, Staccato. Speech in which each syllable is uttered separately; observed in multiple sclerosis.

Speed-sight. One of a pair of sights on a cannon, adjustable in accordance with the estimated speed of a moving ship.

Sperino, Casimiro. A celebrated Italian ophthalmologist, founder of the first polyclinic and hospital for eye diseases at Turin. Born Aug. 31, 1812, at Scarfanigi, Province of Cuneo, he practised first at Genoa, where he specially distinguished himself in the cholera epidemic. After a year or two of ophthalmic study at Paris, under Sichel, he settled in Turin. There he founded the Polyclinic in 1838, the Eye Hospital in 1853. From 1859 to 1873 he was professor of syphilis, dermatology and ophthalmology at the Turin University. He was also president of the medical faculty, and Rector of the University. He wrote no books, but a number of excellent articles, and was an ardent advocate of the repeated evacuation of the aqueous humor as a remedy for many eye diseases. Sperino died in 1894.—(T. H. S.)

Spermacoce verticillata. A South American and West Indian plant used in ocular blennorrhea.

Spermin. A leukomain, C_2H_5N, from semen, sputum, and from various other animal substances. It is a soluble crystalline substance, and has an active tonic and stimulating influence upon the nervous system. It is used in neurasthenia, locomotor ataxia, diabetes, etc., and in all nervous disorders complicated with anemia. Dose, 2 per cent. solution, 8-15 min. (o.5-1 c.c.), subcutaneously.

Experimenting recently on dogs, Mazzei (*Archivio di Ottalm.*, p. 386, Vol. 24, 1918) found that spermin is an active miotic in these animals. He injected the extract directly into the anterior chamber, and found that when 0.4 cc. was used, miosis was obtained in ten minutes. With 0.2 cc. of the extract of spermin injected into the anterior chamber the pupils contracted in 13 minutes, and then after the injection of 0.3 cc. of a 1 per cent. solution of atropin into the anterior chamber of the same eye mydriasis occurred in fourteen minutes. In his experiments the action of atropin solution injected directly into the anterior chamber took from one to two minutes to produce mydriasis instead of from seven to fourteen.

Sph. Abbreviation for sphere or spheric lens.

Sphacelotoxin. See **Ergot,** p. 4507, Vol. VI of this *Encyclopedia.*

Sphagnol. This is a native tar product said to be produced by the decomposition of peaty deposits. It resembles thiol, isarol and ichthyol (q. v.). As an ointment in blepharitis it is recommended in 10 per cent. strength.

Sphenic. Wedge like.

Sphenocephalia. A name applied by G. St.-Hilaire to a form of monstrosity in which the cranium is wedge-shaped, there are two distinct

eyes, the inferior maxilla is shorter than the superior, and the ears approach closely or are even united below the head.

Sphenoidal sinus. See p. 1903, Vol. VI of this *Encyclopedia.*

Sphenoidal sinusitis, Eye signs of. See **Cavities, Neighboring,** and especially p. 1903, Vol. IV, of this *Encyclopedia.*

In addition to this reference A. A. Bradburne (*British Med. Journ.,* Jan. 16, 1915) gives an instance of bilateral *optic neuritis due to sphenoidal sinusitis.* The patient was a married woman, aged 27, in good health. She consulted the writer named in January, 1914. About Christmas she had suffered from a severe cold in the head, accompanied by a copious nasal discharge, but it had cleared up without treatment. Recently vision had become blurred, and there was a tendency to diplopia. Examination revealed a slight weakness of the left externus, the vision in this eye being 5/9. An examination by a rhinologist gave no important data, but the persistent occipital headache was suggestive of sphenoidal sinus suppuration. Tampons of cocain and adrenalin were applied to the body of the sphenoid, with a view of attempting operation, but the patient became so nervous that the operation was deferred. The following day a profuse discharge of thick yellowish pus occurred, which continued for more than a week, at the end of which time the neuritis slowly subsided and the abducens paresis gradually cleared up.

Samuels (*Oph. Year-Book,* p. 236, 1916) reports a case of neuroretinitis from sphenoidal sinusitis. The patient gave a history of having had influenza a few weeks previously, otherwise there was nothing to account for the condition. Physical examination and Roentgen-ray were of doubtful value. After opening and draining the ethmoid and sphenoid sinuses on both sides, the patient made a rapid recovery with restoration of vision of both eyes.

H. Elwin Harris (*Lancet,* Dec. 9, 1916) reports and illustrates with skiagrams a most interesting case in which a bullet appears to have entered by the left inner canthus, and to have passed along between the eyeball and the inner wall of the orbit, until it reached the apex of that cavity. Thence, turning downwards, inwards and forwards, it described an angle of more than 180 degrees, and entered the sphenoidal sinus, wounding in its course the third and optic nerves. So far as eye symptoms are concerned when the patient reached the hospital there were "paralysis of the eyelids" (ptosis?) and left optic atrophy. Harris removed the bullet through the left nostril by an ingenious and successful method.

Sphere, Visual. Cerebral center of vision.

Spheric aberration. See p. 23, Vol. I of this *Encyclopedia.*

Spheric lenses. See the **Eyeglasses** captions.

Spherical lune. The portion of the surface of a sphere included between two great circles.

Spherical mirror. A reflecting portion of a spherical surface.

Sphericle. SPHERULE. A minute sphere.

Spherochlorine. The green of the spectrum of the colored globules of the retina in birds.

Spherocrystal. A mineral occurring in spherical form with fibrous radiate structure.

Spherometer. A micrometer adapted for determining the radii of spheres. One of the best known is that of Weell.

Sphincterectomy. Excision of a portion of the pupillary margin of the iris.

Sphincterentomy. An iridotomy (q. v.) confined entirely to the margin of the pupil.

Sphincter iridis. See p. 6619, Vol. IX of this *Encyclopedia.*

Sphincter iridis (major). Circular muscular fibres of the iris surrounding the pupil.

Sphincter iridis minor. Circular muscular fibres at the periphery of the iris.

Sphincter muscles. These organs surround an opening or canal which, by their action, they are able to close or diminish in size. They are found around the mouth, the opening between the eyelids, around the pupil of the eye, the pylorus of the stomach, the outlet of the urinary bladder, and the anus.

Sphincter of the eyelids. The orbicularis (q. v.) muscle.

Sphincter of the pupillæ. See **Sphincter iridis.**

Sphincterolysis. The operation of detaching the iris in anterior synechia (q. v.). See, also, **Corelysis,** p. 3323, Vol. V of this *Encyclopedia.*

Sphincter palpebrarum. Orbicularis palpebrarum.

Sphincter pupillæ. See **Sphincter iridis (major).**

Sphincter, Vasculolymphatic nervous. A supposed contracting band of fibres at the margin of the pupil.

Sphygmogenin. An old name for adrenalin.

Sphygmomanometer. An instrument for measuring arterial tension or pressure. See, also, **Arterial pressure,** p. 610, Vol. I; p. 1227, Vol. II and p. 10366, Vol. XIII of this *Encyclopedia.* A number of these instruments, of considerable value to the ophthalmologist, are depicted in the text.

The essay of John Dunn (*Archives of Ophthalm.,* Nov. 1908):

review in (*Ophthalm. Review,* p. 208, July, 1909) treats of the value of this instrument in a number of ocular diseases.

Glaucoma. Five cases are described. In two cases of absolute glaucoma the pulse tension was 200 (120 is taken as normal). In a case of acute glaucoma with chronic nephritis the pulse tension was 220. In two cases of chronic simple glaucoma it was 170 and 140. Iridectomy in the latter case checked the progress of the disease for two years.

It would seem, therefore, that, with a high pulse tension (about 200), even though no kidney change may be demonstrated, the chances of checking the disease are extremely bad, and in simple chronic glaucoma at any given stage the prognostic value of iridectomy (surgically successful) varies with the pulse tension—being better the nearer the pulse tension is to normal. In all cases of glaucoma the pulse tension should be taken after the ocular conditions have been noted, and then the urine should be examined. Operative procedures for acute or chronic glaucoma associated with high pulse tension and demonstrable nephritis are apt to be complete failures and may result in the total loss of the eye.

A high pulse tension should also make us extremely cautious in the use of mydriatics in cases where dilatation of the pupil is desirable (owing to opacities of the media, etc.) for ophthalmoscopic purposes. The pulse tension also indicates the desirability or otherwise of blood-letting as a remedial measure in glaucoma.

In cases of corneal ulcer the sphygmomanometer, by showing a high pulse tension, suggests nephritis, the danger of atropin, the possible value of eserin, and the desirability of repeated paracentesis. In the case of slowly developing immature cataract the syhygmomanometer may render valuable help to propriety of operating.

In these cases the author says, "Other things being equal, the case does better the more nearly normal the blood pressure, and I allow this to weigh heavily in making up my mind whether or not to advise the extraction of a slowly-developing senile cataract. . . . As a rule the higher the general blood pressure the greater are the chances that there exist within the intra-ocular vascular system, of old people, degenerative changes which will interfere with the absorption of any lenticular cortex left behind." This, of course, applies to mature as well as to immature cataracts.

In cases of iritis a high pulse tension suggests nephritic complications and indicates that bleeding would be efficacious in the relief of pain, while a normal or low manometric reading indicates the contrary.

In certain cases of retinal hemorrhages the pulse tension may be an important guide, along with other general and local symptoms,

Rogers' Tycos Sphygmomanometer.

The Dial of the Tycos Sphygmomanometer.

in deciding as to the cause of the hemorrhage. A comparatively low tension suggests an infectious arteritis, a higher one, vascular sclerosis, and a very high tension points to a nephritic origin.

Similarly, in cases of inflammatory and edematous conditions of the papilla, the pulse tension often helps us to decide as to the probability of their origin from intracranial growth, nephritis or infective conditions.

In certain cases of pains in the head it will indicate their possible origin from collemia (Haig) and explain the comparative failure of their relief by means of glasses. It also suggests an explanation of the varying refraction of the same eye at different dates of examination.

Sphygmoscope. A device for rendering the pulse beat visible.

Spicules, Ocular injuries from plant. Injuries to the eye by the prickly parts of plants are relatively uncommon although definite forms of infection, e. q., **Hop-pickers' conjunctivitis** (p. 3111, Vol. IV), and **Harvester's keratitis** (p. 6777, Vol. IX), are due to this cause. Martha Kraupa-Runk (*Centralbl. f. prak. Augenheilk.,* Nov., 1914) records a couple of cases of inflammation of the superficial structures of the eye, due in one instance to the spicules of *Arctium lappa compositæ,* and in the other to the barbed hooks of a beard of barley.

Spider, The. Three varieties of spider were deemed of use in ancient Greco-Roman ophthalmology. *Areneus candidus,* rubbed up in oil, was locally employed in albugo; *areneus muscarius* provided a web which was highly esteemed in epiphora, while for the same disease, or symptom, the web of a third variety of spider was tied in a cloth and bound to the patient's person. The bite of *areneus ceruleus* was supposed to lower the visual acuity.—(T. H. S.)

Spiegelbeobachtung. (G.) Mirror observation.

Spikenard. For the use of spikenard in antiquity as a remedy in various diseases of the eye, see **Nard.**

Spina, Alexander de. See **Alexander de Spina.**

Spinal cord, Eye symptoms in diseases of the. This important subject is discussed under the major heading, **Neurology of the eye,** as well as under such minor captions as **Puncture, Spinal**; **Lumbar puncture**; **Tabes dorsalis**; **Cerebrospinal meningitis**; **Infantile paralysis**; **Myelitis**; **Multiple sclerosis**; **Syringomyelia**; **Injuries of the eye,** etc.

In addition to the matter included in the foregoing the *Oph. Year-Book* for 1913 notes that Rönne records a case with acute, severe cerebrospinal disease, which, after a course with marked remissions, ended in death in five months. One month after the onset of the nervous symptoms there was observed in the right eye a retrobulbar neuritis with orbital symptoms leading quickly to amaurosis, but in the left eye characterized by a temporal hemianopsia with an intermittent course just as had been the disease of the central nervous system. The

autopsy showed in the cervical and dorsal portions of the cord, chiasm, tract and optic nerves disseminated plaques which in the visual tracts, in all important particulars, were of the same nature and were significant of an acute disseminated sclerosis.

Maloney states that from a study of the reported cases we must conclude that the absence of spinal implication in primary tabetic optic atrophy is due to the accident of the location of the morbid process and not to an inhibitory influence arising from the localization. Improvement in ataxia will result from a lack of vision after an adequate interval has elapsed; when incoordinating lesions remain stationary, and the mental capacity is not destroyed by cerebral disease; also even if they extend, provided that the effect of this extension be less than the compensating influence of the blindness. No change in the ataxia will follow loss of vision if the advance of the coordinating lesion just neutralizes the beneficent influence of the blindness. Blindfolded tabetics can quickly be taught to appreciate their surviving postural and muscular sense-impressions to such a degree that hopelessly bedridden ataxics quickly learn to walk again.

Langenbeck found retrobulbar affections in 227 eyes of 132 tabetics. In fifty-eight cases of multiple sclerosis in the majority the condition was unilateral, acute, and attended by pain and immediate blindness. None of the symptoms are characteristic, except the fatigue reaction of Uhthoff (a considerable diminution of vision from bodily exertion). In 95 per cent. of all the cases of retrobulbar neuritis there was a central relative scotoma, often with peripheral defects and occasionally hemianopsia. The pupillary reactions showed nothing characteristic. Nystagmus and pareses were more constant: in 50 per cent. eye symptoms alone; in 30 per cent. simultaneous nervous affections, and in 20 per cent. preceding nervous affections were present.

Jas. B. Ayer (*Trans. Am. Ophthalm. Soc.*, Vol. XIV, Part i, p. 205, 1915; review by Stephenson, *Ophthalmoscope*, p. 82, Feb., 1916) writes on lumbar puncture.

The value to be attached to examination of the cerebro-spinal fluid, withdrawn by lumbar puncture, has increased and widened since its introduction some twenty years ago by Quincke. To begin with, puncture was employed only in acute meningitis; but it was then found that chronic inflammatory changes in the nervous system could be diagnosed by its means; and later still, that it was possible to differentiate nerve syphilis from other conditions. Apart from its value in diagnosis, the value of lumbar puncture in treatment is now widely recognized, as seen in the relief of intra-cranial pressure, to say nothing of the administration of certain drugs, as neosalvarsan, by the spinal route.

Ayer presents the results of examination of the cerebro-spinal fluid in 160 cases of interest to the neurologist and the ophthalmologist alike. In most instances the question simply was: Is this condition syphilitic or not? The question was much more important in early stages than when faced by established disease. For example, the information was vital in cases of slightly unequal or irregular pupils, perhaps some with sluggish reaction, of diplopia, of suspected beginning atrophy, and of forms of headache, epilepsy, and migraine. Under these circumstances, the cerebro-spinal fluid might often betray the existence of a syphilitic process.

The cerebro-spinal fluid was examined in forty cases of external oculo-motor palsy, and only five manifested a normal product. The remainder showed evidence of meningeal irritation, as demonstrated by increased number of cells or of proteids, a positive Wassermann reaction, or gold chloride test. A typical instance of the value of lumbar puncture, when oculo-motor palsy is the sole outstanding symptom, is quoted in a patient of 47 years, who awoke one morning to find the right eye closed. The blood yielded a negative Wassermann reaction, but, on the other hand, the cerebro-spinal fluid gave a strongly positive reaction and a goldsol reaction in the syphilitic zone. Ayer summarizes his experience of the cases of oculo-motor palsy as follows: In those not congenital or with other obvious cause, it is usually a manifestation of syphilis of the nervous system. If all tests, blood and spinal fluid, are absolutely negative, the case is probably not syphilis, or represents a run-down process, the signs of which should be evident. In Ayre's experience, oculo-motor palsies due to an active syphilitic process are revealed by both positive blood and spinal fluid tests; occasionally the former is more reliable, but more often the latter.

The cerebro-spinal fluid was examined in forty-four cases of primary optic atrophy, and found to be normal in twelve of that number. The atrophy was mostly associated with a true nerve syphilis, as evidenced by a pathological spinal fluid of syphilitic nature.

Lumbar puncture is contra-indicated by the existence of well-marked choked disc. Unless there be some very good reason, it is wiser in these cases to test the Wassermann reaction upon the blood and not upon the cerebro-spinal fluid. In most cases that is adequate.

Of all manifestations of central nervous syphilis, the abnormal pupil is apt to be one of the earliest. But the changes may be so slight as to leave even a careful ophthalmologist in considerable doubt. The newer laboratory tests, however, may be used to determine whether in a given case the pupil indicates active syphilis or not.

Ayer has examined thirteen cases where the Argyll Robertson was the sole sign, and of these, nine gave a positive test for syphilis, usually as regards both the blood and the cerebro-spinal fluid. The negative cases appear to the author to be explained by arrested nerve syphilis. The value of examining the spinal fluid in cases of Argyll Robertson pupils appears to lie in determining whether the disease in a given case represents an aggressive or a quiescent process. In the one contingency, treatment may arrest the malady almost before it has fairly started, as it were, and in the other there is no need of intensive specific medication. In somewhat the same way, too, irregular pupils (usually the result of syphilis) may be shown to be associated with an active or a past infection.

It is usually not difficult to overcome an oculo-motor palsy if treated early, and Ayer has found, as a matter of experience, that a period of six months represents the time limit for complete recovery. He is by no means enthusiastic concerning the treatment of specific optic atrophy. If taken when far advanced, he regards the outlook as absolutely bad, but if taken early, and the process is proceeding slowly, there is a chance that salvarsan may help. Cases of choked disc of syphilitic origin clear rapidly under treatment with "606."

Ayer lays stress upon the danger attending the little operation of lumbar puncture in cases of raised intra-cranial pressure, especially where there is a subtentorial tumor.

An important contribution to this subject is by Lloyd Mills, of Los Angeles, as follows:

The *normal relations* which exist between the spine and the eyes are mainly those concerned in the mechanics of posture and in iridic innervation of cervical sympathetic origin.

Among these relations are included, 1. Those concerned in the associated mechanics of vision and of more or less finely coördinated manual work, in which stabilization of the head on the cervical spine, of the cervical spine on the dorsal spine and, finally, of the shoulder-girdle on the cervico-dorsal spine and occiput, forming a group of interrelated and instantaneous muscular actions which are hardly less essential to good vision than are the more limited actions of the extrinsic ocular muscles. 2. Those concerned in the proprioceptive or orientative function inherent in the afferent nerve of the cervical muscles and closely related, through the otic labyrinth, with the similar function of the afferent nerves of the extrinsic ocular muscles, as well as with the retinal proprioceptive function; these together forming the main sources which actuate and influence the body with regard to spatial orientation and correct balance. 3. Those concerned in the

maintenance of correct cranio-spinal posture, in which is included those factors productive of compensatory postural changes in the cranium, eyes, spine and shoulder-girdle. And, lastly, 4. Those concerned in the vaso-motor, secretory and trophic functions of the cervical sympathetic system and more particularly of that portion in the cervico-dorsal region miscalled the cilio-spinal "center" because of its concentration of pupillo-dilator fibers.

The smooth and harmonious relation of these allied functions in health usually becomes apparent only when breaks or defects of function occur from faults of organic construction, from injury, from overuse or from disease. Thus, the cranial vault of one of our left-handed patients, was so grotesquely distorted that it appeared as if a sculptor, modelling in clay, had made so wet a mixture that the dome had slipped to the right and had hardened there. This man showed eleven degrees of right hyperphoria, head-tilting and rotation to the left, a droop of the heavier left shoulder and arm, with a corresponding elevation of the right, a dilated left pupil, ascribed to dragging upon the sympathetic as a combined result of head-tilting and rotation and the shoulder position (Wassermann and tuberculin reaction being negative), a strong compensatory lateral spinal curve to further balance the unsymmetrical cranium and with a characteristic history of gastric ulcers, possibly a trophic change in connection with vagus or allied sympathetic disturbance. As an illustration of a probable birth injury, shortly after a primiparous labor of no unusual difficulty and in which forceps were not used, a mother noted that her baby's eyes were slightly larger than usual. This increase in size continued until there was no doubt of the existence of a frank buphthalmus. Counsel was given by various ophthalmologists to wait, to operate, or to do nothing but "let Nature take its course." The child was mentally normal. At this time the tension was high to fingers, the corneæ were steamy, the vision reduced to light perception and the case was considered as beyond relief. While examining the neck for evidence of cervical sympathetic involvement, traction and rotation of the head on the neck produced a sharp click, audible to the mother, and under further traction and rotation, an anterior subluxation of the sixth on the seventh cervical vertebra was reduced with a sharp sound of a bony rub and a cry from the child. Spinal relaxation movements were continued for a time and within two months, without other treatment, vision began to return, the steaminess of the corneæ to clear, the dilated pupils contracted to a size slightly larger than normal and reacted normally, the tension became normal in each eye and vision gradually became so acute that even small pins with colored heads

were seen at some distance on a variegated rug and were promptly picked up by the child without mistake. The child is now four years old and to date, about two years after the cervical reduction, shows no lessening of the size of the globes.

Involvement of the cervical sympathetic in injuries of the shoulder-girdle which cause dragging upon the brachial and cervical plexuses are far more common than is supposed, the symptomatic forms usually being incomplete and transitory, syndromes in which the vaso-motor, secretory and trophic functions of the cervical sympathetic become involved. Where these functions are interrupted there ensues miosis, ptosis, narrowing of the palpebral fissure, enophthalmus, anhidrosis and, often, a reduction of facial sweating on the affected side, which more or less parallels the lessening of the secretion of tears. This syndrome has been noted in projectile injuries of the spine, in compression paralysis from hematoma associated with injury of the brachial plexus at its foraminal exit, and as a complication of carotid arterio-venous aneurysm, of enlarged thyroid (in which connection it was first described as a syndrome by Horner, though recognized by Pourfour de Petit about 1730), and finally, as a complication of enlarged cervical glands and other tumor masses in the neck. In irritative lesions of the neck and cervical cord, among whose causes the postural lesions so commonly seen in the cervical region assume a definite place, the paralytic symptoms are replaced by irritative symptoms, and pupillary dilatation, increased width of the palpebral fissure, from spasm of the superior tarsal muscle, unilateral hyperiodrosis, and very slight exophthalmus are observed in any combination The reason that these symptoms have not been more commonly noted in the cervical and shoulder-girdle injuries is probably because of the severity of the local lesions, as well as the fact that these cases are, in the main, handled by general surgeons who are not especially trained in these finer points of diagnosis. Oftentimes it is difficult indeed, even for the trained observer who is watching for these particular features, to decide upon the presence of a small amount of exophthalmus or of relative widening of one palpebral fissure.

Among the *cervico-dorsal faulty alignments* affecting the eyes, which may correctly be termed irritative lesions, are abnormal spinal twists and rotations, irregular and painful impingements of normal or of abnormally broad lateral processes, overlapping impingements of the posterior spinous processes in cervical lordosis, arthritic enlargements of the articulations, fibrositis and periarticular enlargements of the articulations due to ligamentous strain and trauma, and cervical ribs. In nearly all these cases the muscular spasm and soreness over the

points of muscular and ligamentous insertion denote the undue stretching effected by the faulty skeletal alignment. Another common irritative source is the lateral bending with rotation which occurs in scoliosis, where lateral and antero-posterior deviations of the shoulder-girdle exist with so much stretching of the brachial plexus as to cause brachial pain and parasthesia and that train of symptoms so frequently and incorrectly termed "brachial neuritis" in this connection. The ocular disturbance so often associated with these lesions is undoubtedly due to the reflex effect continuously produced in the cervical sympathetic, to the direct stretching of the sympathetic chain, direct pressure somewhere along the sympathetic course, pressure where the transverse processes are crowded together or where the intervertebral foramina are narrowed by periarticular thickenings and fibrosis. In many of these cases a clear radiogram will show the exact site of the lesion and while, to date, only mechanical intervention by means of traction, braces, massage, gymnastics and hydrotherapy have been used in such cases, it is within reason that surgical intervention may, in time, become a recognized procedure in the more severe and stubborn cases. In considering other phases of this subject, the possibility that such cervico-dorsal lesions (as have been described) may be the origin of certain cases of glaucoma as well as of the obscure cases of heterochromia iridis must not be overlooked. Also from this standpoint the successes which followed many sympathetic fornices can be explained, as well as the persistence of symptoms after surgical interference limited to the eyes. The author makes a routine cervico-dorsal examination in cases of glaucoma and has been struck with the frequency with which the lower two cervical and upper two or three thoracic vertebræ are fused into a rigid, inflexible and often sensitive and painful mass in many of these cases, as well as with the symptomatic relief afforded through deep massage, traction and manipulative lessening of the muscular and ligamentous contractures.

The only practical studies which have appeared to date are those of C. L. Lowman on *the effect of faulty spinal alignment upon the eyes* (*Amer. Jour. Orthoped.*, Dec. 1918) and of Lloyd Mills (The Effects of Cranio-Spinal Form and Alignment upon the Eyes, *Amer. Jour. Ophthal.*, 1919). These investigators recognize that such remote static lesions as flat-foot, hip-disease and other unilateral leg deformities and faults in pelvic alignment, in common with cervico-dorsal and shoulder-girdle deviations are not infrequently associated with eye symptoms which are often lessened or altogether relieved by the correction of the static lesion.

Mills (*ibid*) gives the recent, related literature and, after correlat-

ing the facts with regard to the frequency and severity of anatomical peculiarities in the neck, of the universality and relation of cranial asymmetry and certain forms of spinal curvature, and of their association and connection with irregular astigmatism and ocular muscle imbalance, concludes that

1. Common faults of head posture, hitherto ascribed solely to faults of distribution and action of the extrinsic ocular muscles, often may be due to structural skeletal faults original in the lower extremities or spine, which affect the eyes through their influence upon head posture, as well as through their effect upon the eilio-spinal sympathetic center and the sympathetic pathways.

2. For the purposes of skeletal mechanics the head must be considered as a great terminal vertebra which assumes compensatory postures in the case of postural defects original in the extremities and spine and gravitational postures due to its own imbalance on the spine, unless fully balaneed by compensatory spinal curves.

3. Excluding conditions originating from disease, the basic skeletal faults deemed responsible for many functional defects in the eyes and nose, and eventually for much ocular, nasal, oral and cranial pathology, are those arising from asymmetry of the cranium in connection with the racial prevalence of righthandedness and the less common left-handedness. From this asymmetry spring orbital distorsions and alterations in the positions, muscular distribution and consequently, in the muscular actions of the eyes, the left eye being mainly affected through its proximity to the larger left motor area in the brain and the larger left cranial fossæ, and left hyperphoria, cyclophoria and left relative adductor weakness being the common muscular defects. From this common origin come also asymmetry of the facial bones, of the shape, position and facility of drainage of the nasal sinuses, as well as faults of the bony and cartilaginous septum, of the hard palate, the jaws and the teeth. Much of the facial change called hemiatrophy facialis may also be ascribed to this origin, representing either a compensatory defect of growth or the atrophic effect of the sympathetic involvement which the postural changes have brought about.

4. To balance the unsymmetrically placed weight of the head on the spine, long lateral compensatory curves of the spine, hitherto incorrectly classed as "functional," are developed. These are exaggerated or further complicated by the effect of dextrality or of sinistrality in uncompensated shoulder-girdle deviations, which induce further changes in the posture of the head, thus neutralizing or exaggerating the cranial posture which otherwise would have resulted.

5. These faults of cranial posture influence the proprioceptive func-

tions of the extrinsic ocular muscles, the retina and the muscles of the neck, and undoubtedly put more strain upon the labyrinthine mechanism in its effort to readjust the ocular position with regard to verticality or spatial orientation.

6. Stabilization of the head on the neck and shoulders is a mechanical feature of vision hardly less essential to good ocular fixation and, therefore, to good vision, than is the more limited action of the extrinsic ocular muscles. Stabilization of the shoulder-girdle is equally an essential when finely co-ordinated manual work is the object of the ocular attention. Strains of this stabilizing system through its over-use, and especially in the presence of spinal faults and uncompensated shoulder-girdle deviations, produce the distressing suboccipital, cervical and brachial symptoms incident to reading, sewing, writing and to many occupations which demand careful ocular concentration.

7. Severe ocular muscle imbalance is found more commonly among patients who are primarily orthopedic than among the average eye cases. Cranio-spinal postural defects are found almost uniformly in the eye cases complaining of suboccipital and nuchal aching and are, in the main, capable of relief or cure by methods of relaxation and by appropriate orthopedic and ophthalmic procedure. As a result of such treatment we have noted the lessening and disappearance of ocular muscle imbalance and, in a few cases, a lessening or disappearance of corneal astigmatism.

8. The logical application of this work to preventative medicine is that (a) *Ambidexterity must be insisted upon* during the infantile period and the plastic developmental years. This will produce not only the symmetrical development of the cerebral hemispheres, but is the means of symmetrical development of the cranium and of the superficial and deep components of the face. In this way developmental malpositions of the orbits, the eyes and of the nasal cavities, jaws, teeth and spine will be largely prevented and the pathology, which has its foundation in these early defects, will be avoided. (b) The *prevention of ocular faults resulting from spinal malalignment* lies, obviously, in the early recognition of the spinal defects by the pediarist and by those responsible for our school hygiene, and in the cure of these defects in youth by the orthopedic surgeon, in collaboration with the ophthalmic surgeon.—(L. M.)

Spinal curvature and astigmatism. That continued tilting of the head and shoulders is a not uncommon result of astigmatism and that this form of ametropia may produce lateral curvature of the spine seems to be an accepted theory by many ophthalmologists.

Spinal miosis. The contracted pupil of tabes (q. v.).

Spinal paralysis, Infantile. For the ocular symptoms, see **Neurology of the eye.**

Spinal puncture. See **Lumbar puncture,** also **Puncture, Spinal,** p. 10543, Vol. XIV of this *Encyclopedia.*

Spindelförmiger Staar. (G.) Fusiform cataract.

Spindle cataract. SPINDLE-SHAPED CATARACT. See p. 1748, Vol. III of this *Encyclopedia.*

Spindler, Johann. A well-known German medical historian and ophthalmologist. Born Sept. 8, 1777, at Müsbach, he received his medical degree at Würzburg, and in 1807 was made extraordinary professor of encyclopedia, methodology and medical history at his alma mater. He became in 1913 full professor of the same branches in the same institution. He wrote a treatise entitled *"Ueber Entzündungen des Auges und Ihre Behandlung"* (Würzburg, 1807), and lectured for a time on ophthalmology. In 1818 he received the "Ehrengrad" of Doctor of Philosophy, and died in 1840.—(T. H. S.)

Spinnenwebe des Auges. (G.) Arachnoid tunic of the eye.

Spinoza, Benedict. (1623-77.) Born in Amsterdam, Holland. His parents were rich Spanish or Portugese Jews, but he was formally excommunicated (1656), as a heretic by the church.

His life was entirely uneventful. He earned his living by grinding lenses at the Hague and devoted his leisure to philosophy.

Spinthariscope. Sir William Crookes demonstrated that the emanations from radium produce visible scintillations when they fall on a suitable screen. He invented an instrument to show this, which is called the spinthariscope. It consists of a short brass tube closed at one end by a convex lens, and having at the other a zinc sulphide screen in front of which is placed a radium salt. An observer sees the screen lit up by bright scintillations caused by the impact of particles coming from the disintegrating radium.—(*Standard Encyclopedia.*)

In the description given by G. J. Burch (*Physiological Optics,* p. 89) of *Ramsay's spinthariscope* a minute quantity of radium is brought near a card covered with powdered zinc blende. On examining with a lens the phosphorescent spot produced on the zinc blende it is seen to be caused by a constant succession of flashes, due, it is believed, to the impact of the á-rays of the radium.

To the physiologist these rays afford a retinal stimulus of minimal character and of practically constant intensity, which can be regulated in amount. Being minimal it does not produce retinal fatigue, and is imperceptible until the eye is dark-adapted to a certain extent.

Burch also points out that Gotch's spinthariscope is furnished with the following adjustments: To regulate the density of the cloud of

flashes, the phosphorescent screen can be brought nearer or moved farther from the radium by screwing or unscrewing the cap at the back of the apparatus. After any such adjustment the lens must be focused anew by screwing round the eye end of the tube. The screw slide at the side of the instrument serves to draw the radium to one side, thus reducing still further the frequency of the flashes.

In order to limit the area over which the flashes are visible, a sliding diaphragm is provided. This must be kept closed whenever the instrument is not in use, as the daylight would make the screen phosphoresce with a steady glow, thus spoiling the effect of the radium. It has several apertures, some large and some small, the last being used to study the peripheral regions of the retina.

On first going into the dark-room nothing will be visible. After a few minutes, on looking straight into the spinthariscope, an ill-defined flashing luminosity will be just perceptible.

Direct the eye inwards towards the nasal side, the scintillations, viewed indirectly, appear brilliant and quite clear. Direct the eye outwards, the scintillations disappear. This shows that the nasal region of the retina is in a condition of much greater excitability than the temporal region.

By directing the eye upwards or downwards it may be shown that the sensitiveness to excitation of the corresponding retinal regions is in general greater than that of the temporal region, and greater than that of the fovea, but less than that of the nasal region.

In this respect there seems to be some variation in different individuals, possibly depending partly on the conditions of exposure to light during the previous part of the day.

Spintherism. Photopsia; the appearance as of sparks before the eyes.

Spintheroma. A name given by Blazius to ocular scintillation produced by cholesterin deposits.

Spintherometer. An apparatus for measuring the changes which occur in the vacuum of the x-ray tube, and hence the penetrating power of the rays.

Spinteromma. See **Spintheropia.**—(T. H. S.)

Spintheropia. A name proposed by Sichel to take the place of Desmarres's "Synchisis scintillans," which had already been accepted by Blasius. Though still sometimes employed, it has never come into general use. Blasius, in turn, proposed "Spintheromma," which, however, never succeeded in supplanting either of the other two terms.—(T. H. S.)

Spiracle. Spiraculum. An aperture or orifice.

Spiral field. As noted by Hurst and Symns (*Br. Journ. of Ophthalm.*, p. 17, Jan., 1919) retraction of the field of vision has been regarded as the most characteristic "stigma" of hysteria since Charcot first drew attention to it in 1872. Janet (1911) considered it to be "the emblem of hysterical sensibility in general," and it led him to describe hysteria as a condition due to the "retraction of the field of consciousness." Among ophthalmologists de Schweinitz regards the sign as a "permanent stigma" of hysteria and considers it a very valuable aid to diagnosis. But Babinski (*Semaine Médicale,* p. 3, Vol. 30, 1909) felt himself forced to reject them, as he found none of the so-called stigmata in any of a series of 100 consecutive cases of hysteria, examined in great detail by methods which excluded the possibility of suggestion. Morax over twenty years ago became a convert to Babinski's views. As it is almost impossible to avoid suggesting a narrow field of vision with the perimeter in highly suggestible patients, he has introduced simpler methods for use with hysterical subjects, in which a finger or other familiar object is employed, and although these appear at first to be less accurate, they have the great advantage of making it easy to avoid suggesting abnormalities in the field of vision during the examination.

Apart from hysterical amblyopia, the writers have never seen patients with hysterical symptoms, who spontaneously complained of disabilities resulting from a narrow field of vision, however closely they were cross-examined on the subject. But if a narrow field of vision is produced by testing with the perimeter, the patient may subsequently complain of considerable inconvenience as a result of the cutting off of his peripheral vision.

Hurst and Symns have examined numerous soldiers suffering from various war neuroses, who were abnormally suggestible as a result of the stress and strain of active service, some, but not all, of whom were suffering from gross hysterical symptoms, and have never found any retraction of their field of vision until they were tested with the perimeter. But the perimeter invariably resulted in the suggestion of a narrowed field, however carefully it was used. Moreover, if the examination was continued after the first field was marked out, a spiral field was always obtained identical with that which has hitherto been regarded as a stigma of hysteria. They believe that the reason why a spiral field of vision, which is the natural result of continued suggestion, has not been found in a larger proportion of hysterical cases showing a narrow field of vision is simply because it has not been looked for, the examiner being content when he has marked the limit of vision a single time in each direction.

It has generally been taught that a spiral field of vision is a result of fatigue, and it has even been stated that it is more frequently a symptom of neurasthenia than of hysteria. The above named writers state they have found this is not the case, the inward spiral, which has hitherto alone been described, being a result of the method employed in using the perimeter. They found that an outward spiral is always obtained instead of an inward one, if the white disc of the perimeter is moved outwards instead of inwards, as is commonly done. In this way they often produced an inward spiral for one eye and an outward one for the other, or an inward spiral one day and an outward spiral another day with the same eye. There is no question of any special suggestions made in the method of using the perimeter, as identical results have been obtained by other observers, who marked out the fields of vision without knowing the nature of the cases or the object in view in obtaining the tracings. Moreover, they always obtained normal fields in normal individuals, whether the disc was moved inwards or outwards.

In the course of some investigations on "experimental malingering," 27 individuals, who were pretending that they were paralyzed on the right side as a result of a railway accident, were asked for which they were claiming compensation, whether they could see as well with the right eye as the left. Seven replied that they had noticed some impairment of vision in the right eye. On testing the field of vision with a finger, no narrowing was observed, and they explained that the deficiency they had spoken about was a blurring or general loss of clearness of vision. But when tested with a perimeter all of the seven showed a narrow field on the right side, and one had a slighter narrowing on the left side. In the only two cases in which it occurred to continue the investigation after the first field had been marked out a spiral was obtained, which was identical in character with that supposed to be characteristic of hysteria. See, also, **Hysteria.**

Spirillum. Pl. **spirilla.** A genus, with numerous species (many of which are pathogenic) of schizomycetic microörganisms occurring in coils, differing from *spirochetæ* in being stiff.

Spirit, Bay. Bay rum.

Spirit-level quadrant. An instrument for determining altitudes by the use of the spirit level.

Spirit of Mindererus. See **Ammonium acetate, Solution of,** p. 325, Vol. I of this *Encyclopedia.*

Spirit, Pyroligneous. PYROXYLIC SPIRIT. Methyl or wood alcohol. See p. 215, Vol. I of this *Encyclopedia.*

Spirits of nitre, Sweet. See **Spiritus etheris nitrosi.**

Spirits of turpentine. See **Turpentine.**

Spirits. Spiritus. Spirits are alcoholic solutions of gases, volatile liquids, or volatile solids. A large number are solutions of volatile oils in alcohol and are often used as flavoring agents. With the exception of the spirits of nitrous ether, ammonia, whisky, and brandy, they all make cloudy or milky mixtures when added to considerable quantities of water. This turbidity is due to the separation of the volatile oils or other volatile substances which they contain. Being strongly alcoholic, they are good solvents for resins, oleoresins, and resinous extracts, and they do not cause precipitation when added to fluid extracts and tinctures.

They are usual additions to evaporating lotions and liniments, to be applied to the ocular region for the relief of asthenopic symptoms.

Spirits, Columbian. A trade name for the so-called "deodorized" wood or methyl alcohol, the most insidious and most dangerous of the many forms of methylated spirits in the market. The drinking and inhalation of this poison has been responsible for many deaths and blind people, especially in the United States. See **Alcohol, Methyl**; also, **Methyl alcohol** and **Toxic amblyopia.**

Spiritus. See **Spirits.**

Spiritus etheris nitrosi. Sweet spirits of nitre. This remedy is not commonly employed in ophthalmic therapeutics. Valk uses it in collyria containing silver nitrate (q. v.). He dissolves 5 grains of pure crystals of nitrate of silver in six drachms of distilled water and then adds two drachms of sweet spirits of nitre. This solution will keep much better than the usual solutions, as it does not tend to precipitate the oxide. He believes the free nitrous acid in the sweet spirits of nitre tends to keep the silver in a nascent state and in this way he thinks we get better effect than from the usual solution even when used in much stronger proportions. Furthermore, this solution does not require neutralization with the salt solution, as he has never noticed any untoward effects from its very free use even in the eyes of young children.

H. V. Würdemann employs it in an evaporating solution, which he applies on lintine after silver, copper or other irritating remedy: Sod. bicarb., 2.50; Spt. etheris nitrosi., 4.00; Aquæ camph., 100.00.

E. M. Alger uses it as an adjunct to collyria in from 5 to 10 per cent. mixtures and does not find it irritating.

Spiritus ophthalmicus. A name sometimes given to Pagenstecher's *spiritus ophthalmicus*, i. e., Spt. melissæ, 100; Spt. lavendulæ, 25; Spt.

camphor, 3; Spt. aetheris nitros, 2; Ol. rosæ, gtt., 1. This is used as a collyrium when diluted with 5 or more parts of water.

Spirit, Wood-. Methyl alcohol.

Spirocheta Duttoni. Coppez (*Arch. d'Opht.*, xxxi, p. 353, 1912) discusses the ocular complications of recurrent African fever caused by spirocheta Duttoni. He reports a case with involvement of the optic nerve, which was very red and hazy; but without disturbance of the anterior segment of the eye, except deposits on Descemet's membrane. There was at first a central scotoma; which became a ring scotoma by recovery of vision at the fixation point. The periphery of the field remained normal. The scotoma remained after three months; recovery in a year.

Spirocheta Obermeieri. Sometimes called *Spirillum Obermeieri.* The bacillus of relapsing fever which is sometimes accompanied by eye symptoms.

Spirocheta pallida. TREPONEMA PALLIDUM. This is a spiral organism found in syphilitic lesions and thought to be concerned in the causation of syphilis. See p. 826, Vol. II; **Luetin,** p. 7543, Vol. XI; **Syphilis,** and **Wassermann test,** in this *Encyclopedia.*

In addition to the matter found there it may be added that Sydney Stephenson (*Ophthalmoscope,* June, 1907) believes the name treponema pallidum, as suggested by Vuillemin, to be more appropriate than spirocheta pallida. This organism has been found in all forms and stages of syphilis, whether acquired or inherited, human or animal. It has also been demonstrated in the blood of hereditary syphilitic cases and of those passing through the secondary stage. From the ophthalmic standpoint one notices (a) the discovery of the treponema in the apparently healthy eyes of fetuses and of infants who have died from congenital syphilis; (b) its discovery in lesions set up experimentally in the eyes of monkeys and rabbits by the inoculation of syphilitic material, such as chancres or diseased glands; (c) its discovery in actual syphilitic invasions of the human eye. The author has found the treponema in the aqueous humor of a woman afflicted with iridocyclitis in the course of the early secondaries. He has also found the organism in scrapings from the corneæ of three cases of keratomalacia in syphilitic infants.

William A. Walters (*Journ. Am. Med. Assocn.*) describes the *India-ink method of detecting spirocheta.* A drop of the suspected material is placed on a glass slide, an equal amount of prepared India ink is added and the mixture is smeared fairly thin.

It has come to his attention in using this method that the secondary organisms were usually abundant and that the field in every instance

showed a striking similarity of these secondary organisms. On comparing the slides of the same case made by the prepared India-ink and the field seen with the dark-ground illuminator, it was noted in every instance that many more organisms could be identified with the India-ink than with the dark-ground illuminator.

These two apparently dissimilar results obtained on the same patient with the prepared India-ink and the dark-ground illuminator caused Walters to compare the methods carefully. It was thought the ink itself might contain these organisms, and working along these lines a drop of prepared India-ink was smeared on a clean slide and examined. It was found that the ink itself contained myriads of organisms, many of them long and filamentous, having a wavy contour not unlike that of the spirochete. There were also many other long rod-like organisms present.

To obviate artifacts a dry stick of India-ink was obtained and rubbed with a small amount of filtered water. This was spread on a slide and examined and no micro-organisms could be found.

Walters' method is to rub the dry stick of India-ink with two or three drops of filtered water in the bottom of a small mortar. The filtered water can be obtained at almost any soda-fountain.

No pestle is used in this operation. The stick itself is simply rubbed against the bottom of the mortar as the pestle would be used in triturating. This India-ink solution is then added to an equal amount of material obtained from the suspected lesion and smeared carefully over the surface of a clean slide. A little practice will enable one to judge the proper thickness of the smear. If it is too thin the organisms are not seen well; this is also the case if the smear is too thick. Most stationers handle slate ink-slabs which draftsmen use in rubbing up the sticks of India-ink. They are very convenient, and they can be procured at a comparatively small cost.

This method, while a little slower and less convenient than with the prepared solutions of India-ink, is far more accurate and will obviate all secondary organisms of the microscopic field.

Fontana method of straining spirochetæ. Col. C. Birt (*Journ. Royal Army Medical Corps,* p. 261, March, 1914) remarks that one disadvantage in the various methods of staining spirochetes is that the dye or Indian-ink or the silver preparation generally works best when the material obtained is quite fresh, and in some cases moist and not yet dry; under many circumstances, however, it is necessary to deal with films which have been dried and sent by post, and in this connection Fontana's method of staining them has proved to be one of the best. The detection of spirochetа pallida in a film stained in this way is

accomplished more easily and quickly than the discovery of a parasite in a film of malarial blood, so that the prompt recognition of an infecting sore is within the range of everyone. He describes the Fontana method in detail as follows:

The films of the suspected material are dried in air; they must not be fixed by heat. Huge's fluid, which consists of 1 cubic centimetre of acetic acid, 20 cubic centimetres of formalin, and 100 cubic centimetres of distilled water, is poured over them, and is renewed several times in the course of a minute. After washing with water they are treated with the mordant, which is a 5 per cent. solution of tannic acid in a 1 per cent. watery solution of carbolic acid. The slide covered with the mordant is heated till steam arises, left for half a minute, and then washed with water for fifteen to thirty seconds. Without drying, the silver stain is next applied. This is a ¼ per cent. solution of silver nitrate in distilled water to which ammonia has been added with a capillary pipette until a slight turbidity is evident. If excess of ammonia is introduced, the fluid becomes clear again, and is useless for staining purposes; a trace of ammonia is all that is required. This silver solution is poured on the slide, which is heated till steam is given off, and left for half a minute. The slide is then washed with water, dried with blotting paper, and mounted in xylol balsam if permanent preparations are desired, since cedar oil soon causes the spirochetes to fade. The jet black treponemata stand out prominently on the clear background, and appear to be much thicker than when stained with aniline dyes. They may be identified with the one-sixth objective. They attract the attention immediately, so that if they are present in the film they can be detected in a few seconds or minutes. It is not necessary to be accurate in the strength of the silver nitrate solution; a crystal of the salt dissolved in two or three cubic centimetres of distilled water in a test-tube to which is added a minute drop of ammonia from a capillary pipette, gives satisfactory results.

Spirochetosis ictero-hemorrhagica. Weil's disease. Hepatictyphus. The ocular manifestations of this affection under war conditions is fully described by L. Weekers and J. Firket (*Archives d'Ophtalm.*, p. 647, No. 11, Vol. 35; translation by M. W. Frederick (*Am. Journ. of Ophthalm.*, Jan., 1918). The disease appeared in the Belgian army in August, 1916, and the first cases in the French army were described by Martin and Petit in October, 1916. It invaded the armies on both sides in an almost epidemic form. Although the general symptomalogy has been described in numerous publications the eye manifestations have received but passing notice.

The disease itself does not always present the same picture; on the contrary, it is polymorphic, varying greatly especially as to severity. Certain symptoms, however, are always present, which allow a positive diagnosis. The usual clinical picture is this: the patient, while in full health, is surprised by chills, headache, pains in the body, pains in the muscles, especially those of the neck, lumbar region, flanks, posterior aspect of the thighs, and legs. Sometimes there is hyperesthesia of the skin, and the eyes pain when they are moved. The temperature rises rapidly to 102° or 104°, where it remains for five or six days. During the first period there is great depression, the pulse is small and weak, but not greatly accelerated; the blood pressure is lowered. Nasal and labial herpes, frequent epistaxis, moderate bronchitis with bloody sputum, a dry, dirty tongue; repeated vomiting of bile. Diarrhea is rare, the stools being, as a rule, formed and colored with blue. Liver and spleen show but little swelling. Traces of albumin and large quantities of urobilin are constantly found in the urine, cylindrical casts are exceptional. About the fourth or fifth day the icterus appears, sometimes light in color, sometimes deepening into a dark yellow or saffron. Soon after the appearance of the icterus the temperature drops to near normal, and the patient improves in every way, except that the urine still retains the abnormal constituents, and besides shows biliary pigment.

After five or six days of apyrexia the temperature again rises, and describes a regular curve with wide daily oscillations during a period of six or seven days. This recurrence of fever is better borne than the first period, and during its course the icterus disappears. A long convalescence follows, five to six weeks passing before the blood returns to normal. Cardiac collapse is always to be feared. The mortality ranges from four to eight per cent.

Towards the end of 1914 the causal organism was first described by Inadu, Ido, *et al.* It is a spirocheta morphologically related to the spirocheta of syphilis, and was first found in coal miners. This discovery threw much light on the etiology of the disease, which had been known clinically for many years under different names: "ictère fébrile à rechute de Mathieu"; "typhus hépatique de Landouzy"; "Weil's disease"; etc. In those cases in which the icterus does not occur the diagnosis can be made by inoculating guinea pigs with the blood of the patient during the first seven days of fever, or by examining the sediment of the centrifuged urine passed after the tenth day, when the spirochetæ will be found. The fifteenth to twentieth day the spirochetæ will be numerous.

In fifty cases of spirochetosis icterohemorrhagica the authors found:

No ocular manifestations, 4 cases; simple hyperemia of the anterior segment of the eye, 29 cases; congestion of the iris, 7 cases; iritis, 6 cases; iritis and optic neuritis, 2 cases; iritis and retrobulbar neuritis, 1 case; ocular herpes, 1 case.

The hyperemia is an early symptom, and varies much in intensity. Except in the severe cases, in which there are tears and photophobia, the patients are not much annoyed by the eye condition. Both ciliary and conjunctival blood vessels are involved. The hyperemia does not call for any special treatment, as it disappears spontaneously about the time convalescence begins. In the severe cases the instillation of a few drops of atropin is generally sufficient to cause a subsidence of the symptom.

Iridic irritation and iritis are, as a rule, coincident with the recurrence of the fever, sometimes they are late symptoms. In the iridic irritation we have double miosis with unequal pupils due to the difference in the amount of irritation present in the two eyes. This inequality of the pupils sometimes reverses itself. The pupils dilate slowly under atropin, and when dilatation has attained the maximum the anisocoria disappears. Iritis with exudation into the posterior chamber occurred eight times, was generally of a mild character and ended in a complete restitution. Real synechiæ are rare. One feature of this iritis is the ease with which the exudate in the posterior chamber can be seen, owing to the small amount of infiltration into the iridic tissue and the thinness of the posterior synechiæ, as contrasted with the findings, for example, in syphilitic iritis. Atropin acts much more promptly in the cases under consideration than in other cases of iritis, for the reasons just given. The deposit on the anterior lens capsule, consisting probably of fibrin, disappears slowly, but is completely absorbed finally.

The conditions described seem to the authors to prove the presence of the spirochetes in the uveal tract. The instillation of atropin for four or five days is advisable, even though most of the cases tend to spontaneous cure.

Of the two cases of optic neuritis one was bilateral. The fundus changes, while not severe, were readily recognizable. There was some lessening of vision, but no retraction of the fields, nor was there a central scotoma. Both cases resulted in a complete cure. The one case of retrobulbar neuritis terminated favorably also in a short time. The authors think the presence of the spirochetes in the cephalo-rhachidian fluid was the causative factor. The one case of ocular herpes occurred early in the disease, and affected the lids, conjunctiva, and cornea. The icterus of the conjunctiva is a part of the general picture.

and has, therefore, no local significance. In three cases subconjunctival hemorrhages were seen, being situated towards the inner and outer canthi in both eyes. In no case was a hemorrhage into the deeper tissues or into the orbit observed. The reports of five cases are given in detail.

It is of interest to note that the finding of the Japanese investigators that the field rat is the probable carrier of this infection has been confirmed by Stokes, Ryle, and Tytter (*Lancet,* Jan. 27, 1917), and by Eggstein (*Jour. Am. Med. Assocn.,* Nov. 24, 1917).

Spirone. A preparation of acetone, potassium hyposulphite, iodin, glycerin, and water: used as a disinfectant and as a substitute for potassium iodid.

Spironema pallida. Same as spirocheta pallida.

According to Clifford Dobell (*Reports of the Medical Research Committee, London,* 1918) this is the correct name of the spirochete of syphilis. The names *Treponema* (q: v.) and *Microspironema* are without validity.

Spittle. Saliva, as a medicinal application to the eye, is of very great antiquity. Thus, this substance was so employed centuries before the time of Christ, and the use of spittle by Jesus when engaged in restoring sight miraculously, would seem to have been a concession to the popular practice of the day. (See **Jesus of Nazareth.**) Spittle was employed until about the middle of the 19th century, by "cataract-prickers," on the point of the cataract needle by way of preparation for a couchment. It is hardly necessary to add that, in spite of its septic character, spittle is still employed as a popular remedy both for diseases of the eyes and other organs of the body.—(T. H. S.)

Spitzka's bundle. See **Bundle, Spitzka's,** p. 1338, Vol. II of this *Encyclopedia.*

Spitzkopf. (G.) Oxycephaly.

Spleenwort. *Asplenium.* In ancient Greco-Roman times, boiled spleenwort was frequently employed as a remedy for ocular injuries, especially "black eyes."—(T. H. S.)

Split nut. See **Physostigma,** p. 10214, Vol. XIII of this *Encyclopedia.*

Spodiacon. Spodiacum. A certain old, ash-colored collyrium.

Spondylitis. Inflammation of a vertebral joint. Pott's disease.

Sponge, The. In Greco-Roman antiquity three species of sponge were employed in the treatment of eye diseases: *achillium,* or *penicillium; manon;* and *tragos.* These were commonly soaked in water, wine or mead, and applied as poultices. Sometimes, reduced to ashes, they were sprinkled into the eyes.—(T. H. S.)

Sponge holder. This useful device is used, in common with many other instruments, both in general and in ophthalmic surgery.

Spongy exudation into anterior chamber. This condition is seen in several infections of the uveal tract but especially in iritis and after cataract extraction. It begins with pain and swelling of the lids and conjunctiva. The pupil becomes contracted and there is a turbid exudate like a cobweb situated in the anterior chamber. The condition disappears in about a week without treatment.

Spongy iritis. See p. 6672, Vol. IX of this *Encyclopedia*.

Spontaneous absorption of cataract. Verrey (*Clinique d'Ophtal.,* April, 1916) describes a case of spontaneous absorption of a cataract and draws conclusions from the findings of others. Spontaneous absorption of a cataract is always a slow procedure and is preceded in the great percentage of cases by inflammatory phenomena, iritis, etc. The intraocular infection penetrates the lenticular capsule, starting a "phakitis," with frequent variations in the intraocular tension, then liquefaction of the lens fibers with more or less absorption of these and in fortunate cases rupture of the capsule, leaving a black pupil and vision never exceeding 1/6.

Koster (*Zeitchr. f. Augenheilk.,* I-II, 1916) remarks that although spontaneous resorption of the uninjured lens in advanced age has been repeatedly described, its occurrence is nevertheless very rare.

In 1913 Koster saw a healthy man of 77 years who stated that in his 50th year he had begun to suffer from cataract; with the right eye especially he was very soon unable to see; in the left eye the cataract progressed but very slowly. Twenty-five years ago, i. e., 2 years after his affliction had begun, Prof. Snellen proposed the extraction of the cataract in the right eye, but patient had refused. Up to the time when Koster examined him he had been able to do his work fairly well with the left eye. He had never suffered from diseases of the eye nor from other diseases frequently associated with cataract; the cataract had been diagnosed previously, and now by the writer as a senile cataract.

The author found, on Jan. 22, 1913: V. O. S. = 3/60, with + 2.5 = 6/24; cataracta rubra centralis. V. O. D. = 0.5/50, with + 9 = 6/60. Deep anterior chamber with cataracta membranacea which in several places when light was transmitted, allowed the penetration of red light. When the pupil was dilated no remnant of the nucleus of the lens could be found either with focal illumination with a loupe, with transmitted light or with plus 20 behind the ophthalmoscope. Normal pupils on both side, normal tension and good projection. It was, therefore, a case of spontaneous resorption of a senile cataract

of the right eye. Jan. 27, 1913, discission of the membranous cataract with 2 needles according to Schweigger. Jan. 30, V. O. D. with + 10 = 6/12. Oct. 13, V. O. D. with + 10= 6/6.

No swollen remnants of the lens were visible in the pupil. The lower V. during the first three days after the operation was caused by mydriasis, as the remnants of the cataracta membrancea still disturbed the vision somewhat.

In this case the author saw an uncomplicated cataract in a man over 50 years of age clear up completely in the course of less than 25 years, and although the membranaceous cataract still disturbed his vision considerably, this membrane, too, would probably, if no operation had been performed, have become more transparent; without the slight operation, however, vision would scarcely have attained 6/6.

It has been impossible to find any cause for the resorption of cataract; in patients of this sort there must be some determining factor, either in the whole body or in the eye, for this unusual process, since the lens does not become over-mature and calcified in the usual way, but from the very start is affected in a different manner by the fluids of the eye and, although very slowly, dissolved. It would be a great triumph if we could start this process at will, for some patients would undoubtedly prefer such spontaneous cure, no matter how satisfactory the results of the operation for cataract are. It does not seem impossible that we may yet be able to accomplish something in this direction.

In connection with the just mentioned spontaneous cure of senile cataract, we may be permitted to remind the reader that the same thing happens in young children. In those cases we are not in a position to state that the cataract is not a traumatic one or that a trauma may have precipitated the absorption of an already existing cataract. We then, as is well known, find only a cataracta membranacea. See, also, p. 1450, Vol. II of this *Encyclopedia.*

Spontaneous blennorrhagic conjunctivitis. A name sometimes given to strumous conjunctivitis.

Spontaneous cataract. A cataract occurring idiopathically; a simple cataract.

Spontaneous dislocation (luxation) of the lens. In addition to the matter on p. 7202, Vol. X of this *Encyclopedia,* Jacqueau (*Clinique Ophtal.,* June, 1911; reviewed in *Ophthalmoscope,* p. 46, Jan., 1916) reports the following remarkable case: A man, aged 32 years, without pathological antecedents, and without any congenital malformation, had up to his twentieth year perfectly good sight, as judged by the standard of other people. Towards the age of twenty he developed myopia, and was treated by three different competent ophthal-

mologists, none of whom discovered anything beyond the myopia. When aged twenty-five, he had a severe fall from a bicycle, but noticed no change in the vision as a result. In 1908 this patient first consulted Jacqueau, who found myopic astigmatism and corrected it as follows: R. E. — 11D. sph. ⌒ — 4.5D. cyl. 180°, V. A. = 1/3 barely; L. E. — 4.5 D. sph. ⌒ — 2 D. cyl. 180° V. A. = 5/7. A slight tremor of the iris on each side caused the author to warn his patient of the possibility of luxation of the lenses. On 6th October, 1910, the right lens became dislocated into the anterior chamber while the patient was stepping out of a bath. The eye became glaucomatous, owing to some slight delay, and then, under general anesthesia, the lens was extracted without any loss of vitreous. There was found, unfortunately, a vitreous hemorrhage which, up to the time of writing, had not completely absorbed. On the 21st of December of the same year the lens of the left eye dislocated into the anterior chamber while the patient was walking along the street, without any trauma and without any pain. Extraction was performed the next day under general anesthesia. There was a slight loss of vitreous. The vision of this eye was actually improved.

In discussing the pathogenesis, the author considers that there must have been a congenital weakness of the zonule, which latter gradually stretched by the weight of the lens up to the point of actual rupture. He was, in fact, able to watch part of this process during the interval between the two dislocations; the left lens being observed gradually to sink and to expose its upper border. Jacqueau remarks that although he was prepared for the second dislocation, he was not prepared for its occurrence into the anterior chamber exactly as in the other eye.

Spicer, of London, reports (*Trans. Ophth. Soc. U. K.*, Vol. XXXV, 1915, p. 353) the cases of one boy and two girls belonging to the same family, aged three, five, and eleven years respectively, with dislocation of the lenses, and in two of the three instances with displacement (ectopia) of the pupils upwards or downwards, as the case might be. The lens lay in the anterior chamber in one eye of two of the children. while in the third, owing to contradictions in the text of the communication, it is impossible to say whether one or both lenses lay in the anterior chambers. The cause of the dislocation was unknown, except in the girl of eleven years where it followed traumatism in one eye. Two of the dislocated lenses were treated by scoop extraction.

Another example of apparently spontaneous dislocation of the lens is reported by F. Krauss (*Ophthalmic Record*, August, 1915). The dislocation took place without injury or other cause. Extraction was

carried out with loss of vitreous. The lens was hard in texture and of a dark-brown color. Three months after operation with a suitable correction vision was 5/7. Examination of the lens showed that rupture of the zonule had taken place.

Pons relates (*L'Ophtalmologie Provinciale,* April, 1912) the case of a farmer, aged 40 years, with dislocation of the right lens into the anterior chamber. He had been able to find little or no literature on the subject. Four years previously his patient suffered from the same condition in the left eye. Pons believes that the dislocation was due to liquefaction of the vitreous and atrophy of the suspensory ligament. Other factors must be taken into consideration, for example, myopia, choroidal disease, senility, and deficient vitality.

Spontaneous gangrene of the eyelids. See p. 5007, Vol. VII of this *Encyclopedia.*

Spontaneous hemorrhage into the orbit. In addition to the matter relating to this subject on p. 5798, Vol. VIII of this *Encyclopedia,* Carlo Pissarello (*Archivio di Ottalm.,* xxii, 3, 1915; review in *Oph. Review,* p. 27, 1916) reports an instance of this rare occurrence. A peasant, aged 47, stated that four days previously, while engaged in his accustomed work on the farm, suddenly became affected by an intense headache, which lasted with severity for a few hours. In the evening after supper he went to bed, but though not restless he did not sleep well; he had no pain, however. Yet in the morning, as he was astonished to discover, his left eye was much protruded as compared with the right one. During the three days that had elapsed before Pissarello saw him this proptosis had been maintained, and had been accompanied by very annoying diplopia.

In the history of the patient there was nothing to suggest a cause. When a little boy he had received a kick in the face from a horse, but the resulting scar, which ran outwards from the root of the nose, was in the skin alone and was mobile; it did not appear to implicate bone at all. The following year he received another injury to the face by falling on the ice; the left eyebrow was cut vertically at the junction of the outer and middle thirds; the linear scar resulting was still obvious. Again the bony structures were not implicated—at all events there was no irregularity of outline to be made out. At 18 he was affected by typhus, and—which is perhaps a more significant fact—about the age of 21 he suffered from repeated attacks of copious epistaxis. About his 37th year he suffered from some intestinal trouble for some months, and since that time has eschewed the use of wine, and has been particularly careful regarding diet.

The patient was observed on examination to look very pale, and his

appearance suggested that he was several years older than his stated age. The left eye was so protruded that it might be said to be out of the orbit altogether, and it stood at a level lower than that of the other. The outlines of the orbits, on careful palpation, seemed to be exactly similar; the fact that the right eye was particularly deep sunk in the orbit, owing to the grave emaciation of the patient, added very considerably to the apparent degree of the exophthalmos on the other side, and consequently to the deformity. In the upper lid there was a large, well-delineated ecchymosis; there was no suggestion of any inflammatory swelling; the lids could not be closed over the protruded globe. In the lower part of the eye there was considerable chemosis, and there was an ulcer of the cornea from exposure, but the iris was normal and reacted well, and the aqueous was clear; the fundus, too, was normal. It was impossible to reduce the proptosis by compression; the patient suffered little pain, only a sense of weight. No bruit could be heard, and expiratory movements with the nostrils closed did not increase the protrusion. The urine contained neither sugar nor albumin; Wassermann reaction was negative; there was slight cardiac enlargement and an accentuated second sound; investigation of the blood gave reds to whites as 4,900,000 to 8,000, with hemoglobin at 90. The arterial tension stood at 160 to 163 mm.; the temperature remained normal.

From these circumstances it was plain to Pissarello that the proptosis was due neither to a tumor, nor to emphysema, nor to aneurysm, nor to a merely paralytic condition, nor to a frontal sinusitis. The comparative absence of edema of the lids and of the temple, and the lack of any general condition to account for it made thrombosis a very improbable explanation; it became almost a certainty that the nature of the disease was hemorrhage into the orbit. On the ground that on the first onset of diplopia it appears to have been vertical, Pissarello considers that this hemorrhage must have taken place first at the upper part of the orbit, for the eye was depressed as well as protruded; and he suggests that it may have been subperiosteal, but the scaffolding of facts seems to the reviewer somewhat insufficient to support this theory. The author considers this suggestion of his to receive support from the appearance of ecchymosis in the upper lid and not in the lower.

Five days later Pissarello drew off the extravasated fluid with a syringe, and obtained 8 c.cm. of a blackish fluid containing numerous degenerated red-blood corpuscles. Some relief of the proptosis was thereby obtained, but for fear of septic invasion, and because the ulcerated condition of the cornea was becoming worse, Gaudenzi, under

whose care the patient was, cut down, removed the altered blood from the apical portion of the orbit, and united the lids by a stitch. The patient made a good recovery, the aspect becoming normal and the globe resuming its mobility.

Pissarello notes in several published cases the patients were scorbutic; in several more infantile scurvy or Barlow's disease was present; indeed Heubner met with spontaneous hemorrhage into the orbit four times among sixty-five cases of Barlow's disease. Some of the patients showed a tendency to hemorrhages in other parts also. Hemophilia was observed by some five writers, but in these cases the hemorrhage was usually not subperiosteal, but in the cellular tissue in the orbit, contrasting strongly in this particular with those of the class just mentioned. Orbital hemorrhage has been observed once or twice in cases of enteric fever also. Some clinicians have recorded cases occurring in Bright's disease, and along with cardiac disease and general vascular sclerosis. It has been noticed, too, to follow at a long distance of time a blow on the supra-orbital region, and (like more superficial extravasations) to occur in whooping-cough or other severe cough. Other causes assigned have been hemicrania and suppression of the menses, while in a considerable number the author was unable to suggest any definite cause.

The prognosis is serious, for the presence of the blood may necessitate surgical interference, and the mere extravasation may have a disastrous effect on certain of the orbital tissues, but the prospects naturally depend to a large extent upon the underlying cause of the hemorrhage.

G. F. C. Wallis (*Ophthalmoscope*, p. 189, May, 1916) also reports two cases; the first that of a girl of 12 years, a pupil at a private boarding school, who had two attacks of bleeding from the right eye with an interval of two months between. The hemorrhage, of about two drachms in quantity, and venous in type, arose from a localized hyperemic area of the conjunctiva and episclera in the neighborhood of the lower fornix. On a third occasion the appearances were clinically identical, but no bleeding took place. Premonitory edema of the lids set in on the preceding day before all attacks; wilful traumatism was excluded; apparent relation to the catamenia. This affection was possibly of the nature of *episcleritis periodica fugax*.

The history, as given by the school matron, was: "The eyelids of the right eye and the eye itself became slightly red, swollen, and a little painful yesterday morning. She did her school work as usual and slept well last night. This morning, whilst writing at her desk, the eye began to bleed. I tied the eye up and made her lie down until

ready to bring her; when I removed the handkerchief, a big clot, which filled the eye, came away. As her parents live in Japan, she spends the holidays at school, and during this last Christmas holiday she had a slighter attack of bleeding from the same eye.'' On further enquiry, it appeared that the day preceding the trouble in the holidays the eyelids were puffy and the eye inflamed. The class mistress and the matron were quite sure that there had been no injury.

The patient looked, and from examination appeared to be, a healthy child in every way; no cough or nasal disease; tongue clean, bowels regular; occasionally irregular menstruation. The third attack—unassociated with loss of blood—took place during a normal physiological menstrual flux.

Locally, nothing was to be observed as to why the right eye should have been affected more than the left, or why only a small area of the conjunctiva was involved. And it is evident that a localized and acute hyperemia, such as was present in the case under discussion, must arise through a relaxation of the vaso-motor nervous control, either through some toxin, or, more probably, through a disturbed central nervous system, the result of the recently developed uterine function. One sees a somewhat analogous state of disturbance in the vaso-motor control, giving rise to tiny, acute, ephemeral chilblains on the back of the hands and ears—analogous, that is, in the clinical aspects of the affection.

The clinical features of this case, including the prodromal swelling of the lids, were very like those of *episcleritis periodica fugax,* and it is possible that this was an atypical attack. However this may be, it would seem that, given an intense hyperemia situated in the conjunctiva and episclera, at the transition to the fornix, where there is a plexus of veins (Fuchs), a resultant hemorrhage would not be an entirely unexpected event.

Spontaneous iridochoroiditis. A primary iridochoroiditis; in its inception merely a cyclitis.

Spontaneous rupture of the anterior capsule. Wm. Zentmayer *(Am. Journ. Ophthalm.,* May, 1919) reported a case of this extremely rare accident. A cataract due to a break in the anterior capsule of the lens revealed by the dilatation of the pupil in an eye with an apparently perforating corneal ulcer occasioned surprise which turned to astonishment on the later occurrence of a similar condition of the lens and its capsule in the fellow eye showing no recent signs of trauma or inflammation. O. M., female, aged 19 years, came to the Wills Hospital October 9, 1918. She was employed in weighing powder in a munitions plant. The left eye had been sore for ten days. There

was no history of trauma. She was an epileptic. There was moderate photophobia and lachrymation with marked ciliary congestion. The cornea was hazy throughout and showed a perforated ulcer in its lower-inner sector corresponding to the position of the pupillary border of the iris. The iris was engaged in the ulcer and the pupillary area was opaque. This was at the time supposed to be due to exudation. Later, however, when the pupil had been dilated with atropin it was determined to be opaque lens-matter protruding from a rent in the anterior capsule. V. = L. P. In the right eye the cornea showed fine linear and curvilinear gray opacities in its lower and also temporal portion. On the temporal side there was an absence of complete differentiation between the corneal and scleral tissue and there was what appeared to be a small, congenital symblepharon. Fundus normal. V. = $6/12$.

She was admitted to the hospital, an X-ray was made and appeared negative. Under appropriate treatment the inflammation subsided and when she was discharged on October 21 the globe was white and the anterior chamber shallow, pupil nearly round, there being a slight anterior synechia. The lens was opaque and cortical substance protruded from the rent in the anterior capsule. V. = hand movements.

After her discharge she was seen a few times in the dispensary for treatment of the affected eye, and on October 25 she again reported, stating that two days previously on arising in the morning she was unable to see to go to work. Vision gradually grew worse. There was very slight ciliary injection; the cornea showed the condition previously noted and the lens was cataractous, cortical matter protruding into the anterior chamber. V. = hand movements. On December 4 a linear extraction was done on the right eye, and on December 16 a needling of the remaining cortical portion and capsule. January 13: V. = $20/100$ + 13 D.

Two possible explanations of the condition present themselves: (1) Tetany and (2) self-induced trauma. Tetany is a well-recognized cause or accompaniment of cataract. A history of convulsions is present in a not inconsiderable percentage of zonular cataract cases and there are observers who claim to have found tetany a cause or accompaniment in many cases of senile cataract. It is possible that the associated conditions in the first instance have a common cause in a disturbance of metabolism arising from abnormalities in the secretion of one or more of the endocrine organs. Whether repeated convulsions could cause a rupture of the capsule in a normal development is doubtful when we consider the frequency of epilepsy and the absence, so far as Zentmayer knew, of any previously reported cases

of cataraet arising in this way. It is conceivable that there may have been a structural weakness of the capsule through faulty development. The theory of self-induction in this ease would have had stronger support if the eataraet had been combined with a corneal lesion in the seeond eye. But in this eye there was no evidenee of a recent wound or ulcer of the eornea. When the patient presented herself, two days after the loss of vision had been noted, the anterior chamber was shallow and the eye was slightly injeeted, both symptoms were probably due to the swollen lens. Lewis Ziegler stated that the three prominent faetors to be studied in Zentmayer's ease of ruptured eapsule were ehemieal erosion, uleeration and trauma from the convulsive seizure. Undoubtedly the ehemistry of metabolism in an epileptic was always perverted, but whether this eould extend to the lens substanee was diffieult to demonstrate. He had seen a ease of execedingly irritating ehemieals in a lens eortex that produeed an exaeerbation of glaueoma whenever the eapsular contents eseaped. Uleeration eould only be considered by analogy as the history shows sueh a lesion on one eornea just over the ruptured eapsule. Weakening of the capsule, either by erosion or uleeration would undoubtedly eneourage traumatic rupture in a ease of epileptiform eonvulsion, but the exaet lesion of the eapsule could only be determined by withdrawing the ruptured eapsule for mieroseopie examination. This might prove diffieult to aeeomplish.

Spontaneous rupture of the eyeball. Ball, Gilfillan and Millikin have seen eases. They present a pieture identieal with that found in the third stage of sarcoma of the ehoroid. The history of the ease, and the exeessive rarity of spontaneous rupture, will serve to elear the diagnosis. See, also, **Rupture of the eyeball.**

Spools of Schenke. Yarn-eolored spools used to deteet eolor-blindness. See p. 5099, Vol. VII of this *Encyclopedia.*

Spoons. See, also, **Curette** headings. Under the head of spoon-shaped instruments may be elassed the seoops of Daviel, Graefe, Pagensteeher, Knapp, Critehett, Noyes and others; the ehalazion eurettes of many models, enueleation spoons and exenteration seoops.

G. Hays' enueleation spoon (*Trans. Am. Oph. Soc.,* p. 2147, 1874) is a two-branehed blunt spoon. The branehes are smooth, thin plates, so shaped as to fit the posterior surface of the eyeball. They are somewhat parallel with eaeh other, long enough to pass about three-quarters the way around the posterior half of the eye, and separated by an interval of a quarter of an ineh to allow the optie nerve to pass between them.

Clark (*Oph. Year-Book,* p. 185, 1916), has deseribed a new eataraet

spoon of extreme thinness for use in soft cataract extraction with keratome incision. In its construction it is much more delicate than other spoons used for similar purposes.

Pictured in this text are the sharp spoons or curettes of Meyhöfer.

Meyhöfer's Spoon (Sharp).

Spore. The seed or reproductive element of one of the lower organisms, such as a cryptogamic plant or a protozoan.

Sporoblast. A spore mother-cell formed by the union of two gametes in certain sporozoa. It consists of a mass of protoplasm from which a single spore develops.

Sport, Ocular problems in. This subject is of some importance to the ophthalmologist and has been touched upon occasionally in this *Encyclopedia.* See, e. g., **Marksmanship.**

Robt. W. Doyne (*Ophthalmoscope,* Jan.-March, 1915) has given by far the most complete account yet published of the relations of the eye to certain popular games and sports, and these are largely republished here.

Baseball. The ocular relations of our national game should have first place in this section, not only because of our particular interest in it but because the ophthalmic phenomena one is called upon to study reach their highest development in a pastime that calls for the interest and alert use of the whole visual apparatus not only on the part of the players, umpire, managers, etc., but by the observant "fans," each of whom has his own opinion (based on visual experiences chiefly) as to whether a baseman has touched the incoming player with the ball or not; whether the runner has reached, and actually touched, the base before the arrival of the ball; when the ball is struck it is often a nice test of vision to say whether it is a "foul" or not, etc. So, during the whole course of the nine or more innings tests of accommodative vision are numerous, but not on the whole, more frequent than in, say, tennis or cricket. In the latter game, however, a much smaller percentage of the contestants are in play during the game, and the strain upon the musculo-nervous system of the participants is greater than in most games in which a large number of players are engaged. Again, as opposed to cricket, baseball is a short and strenuous performance; participants seem to crowd into

a few hours the incidents that in the English game (a more deliberate performance) may occupy the same number of days.

While this is all true the accommodative acts and the exercise of visual acuity are pretty much the same as one finds them in most outdoor sports. The reader is consequently advised to read the remainder of this section, (but especially the sub-section, *cricket*) in which all these conditions are specifically treated.

In the same way the ocular relations of *handball, racket* and similar indoor games—the eye problems of the former being well considered under the sub-head *Lawn tennis.*

Croquet. The ocular requirements in croquet are similar to those in billiards. To determine whether the ground be fast or slow requires judgment in the same way as do the cushions and cloth of a billiard-table. Among first-class players this requires a greater degree of accuracy than is claimed for the ordinary moderate player, who does not rely to the same extent on cutting the ball in various directions. In the old days of croquet the main difficulty used to be hitting a ball, but nowadays a much greater degree of accuracy is required in getting through a hoop than in striking a ball. In all except close shots, players presumably do not make any other attempt than to strike the ball with such degree of strength as to constitute the rush necessary to move the ball the required distance. The question as to what angle a ball should be struck is not usually considered in what are known as long shots, although the possibility can be recognized of a marvellously good player considering upon which side he should strike the ball from a distance of one end of the court to the other. Generally speaking, however, this consideration is reserved for closer shots.

Perhaps the most interesting problem in croquet is whether the eye should be used in the horizontal plane or in the vertical plane, that is to say, whether a facing or sideways attitude should be adopted. This selection is modified by the conditions of play. For freedom and power in striking the vertical plane is probably the best. For a dwelling stroke, in which the aim, having been made, has to be continually maintained during the stroke, the horizontal plane is best. Anyone, who has not played any other game, would select, at any rate at first, the horizontal plane, but those who have been trained to make use of the vertical plane, as in golf, would adopt the position to which they are accustomed and in which they have been trained. If conditions of sight were alone considered, the horizontal plane, in which the mental line of vision, i. e., a line from a point midway between the two eyes, is being used, would be best. This is more advantageous for

judging angles than the vertical plane, in which direct alignment is used, but which does not give the same intuition about angles. In playing in the horizontal plane, the player should incline his head over the mallet, the degree being modified by judgment, so that the mallet, the ball and the distance to the object ball are all aligned in the vertical plane with the mental line of vision. This is not so, if a man plays between his legs, in which case no leaning of the head is required, and which is only necessary in a modified degree in those who make use of one eye only. These are, however, real exceptions, and probably no normal-sighted man adopts this latter procedure, although it is constantly claimed by certain players that they use this or that eye in aiming. As a matter of fact, although possible, it is very rare for the normal-sighted man to align with one eye. This can be proved in this way. If a player, after having taken aim with both eyes open, covers first one eye and then the other, without moving in the least degree, he will observe that neither eye is in alignment. In the act of striking it is important to keep the body absolutely steady. In order to do this, the player should fix with his eyes some point, as in golf or billiards. It does not matter, and this point is elsewhere emphasized, whether after taking aim the player fixes the distant ball or his own ball, or some point between the two. Of course, the system the player has practised will be the one he thinks most essential. The writer lays stress on this, because it is so common to hear dogmatic opinions expressed on the subject, for which there is no foundation except the individual's own practice.

Lawn tennis. In this game there are several manifestations of the eye. Immediately on treading on the court the brain process begins. The player knows from the feel of the ground whether it is fast or slow, lumpy or true, and this will qualify materially his judgment of the behavior of the ball. The surroundings and the orientation of the court, too, are important data for judgment. The service of the experienced player illustrates a high degree of brain judgment. The beginner, when he first takes a racquet in his hand, usually takes aim by deliberately presenting the centre of the face of the racquet to the ball. Then he withdraws the racquet and puts it over the net, quite high up to be clear of the net. The only real judgment that is used, and that is of the very slightest, is the strength to strike the ball so that it shall fall within the service lines, and practically no judgment is required in getting it widely above the net. Brain judgment proceeds in all directions, so that, eventually, in service the ball may be struck without looking at it. Of course, this is not always the case, for elaborate judgment is used by some players who throw

the ball in the air and then strike it as it falls. Judgment is developed to such a degree as to the height of the net that it becomes almost a sub-conscious fact, and acts as a constant control on each stroke, and has probably a much greater effect on the delivery of quick service than the actual service lines. Individual peculiarities of service, such as cut and screw, require peculiarities of style which form important data for the opponent. The art of serving is carried to a very high degree of perfection by adepts at the game. Probably one of the most important details in acquiring proficiency is always to try to do the same thing, not to serve hard when opposed by a particularly formidable adversary, and less hard when not so situated. If it is not desired to send hard service it is well to adopt another style completely, so as not to upset the deliberately co-ordinated association of muscles that has been trained to deliver a most effective service. Forcing in service is on a par with forcing in golf. When the increased impulse is given to the associated muscles, such impulse is not correctly co-ordinated among the group of muscles that is employed, and consequently some muscle overacts, and the effect on the ball does not correspond with the results anticipated from previous practice. The point is one that has not been sufficiently recognized by beginners, for it encourages a sort of uncertainty and stammer in the action of the associated muscles.

As to the receiver of the service, it is a very interesting problem to try to discover the first moment a player perceives the approximate place at which a ball will pitch. Of course, this is an extremely important point, and the player who has the earliest conception of this is immediately placed in a position of advantage. The writer has often inquired from experienced players how soon they get a conception of this, not only in service but during the course of the game. He has been told that a player himself can so place a ball that it is only possible for his opponent to return it in a certain direction, so that, as he is striking the ball himself, he can be prepared for the approximate place on which the ball will be returned to him. This is a wonderful insight into the future, and its counterpart is often found in the sequence of events in other conditions of life. In service the earliest indication that the writer has known a player claim as to where the ball is going to pitch is the position of the face of the opponent's racquet, even immediately before and at the moment of striking the ball. After this, there are, of course, varying degrees of perception and the relation of the balls principally to the net and other surrounding conditions has enabled the player to estimate more or less accurately the spot on which the ball will pitch. Inexperienced

players, of course, hardly form a conclusion before the ball has pitched, and then begin to run towards it. As experience advances, so a conclusion is formed at earlier periods and the player accordingly moves earlier to a position best adapted for returning the ball. There are other details that form important data in coming to a correct conclusion, such as the direction of the server's head and the direction of his gaze, for it will be recalled how often a player, at any rate an inexperienced player, can be deceived by the striker looking in one direction and directing the ball in another. The effect of putting "cut" and "screw" on the ball must be learned, and that it is being used should be observed from the action of the striker, and when the effect is thoroughly appreciated by the opponent, the brain judgment is immediately modified accordingly. "Screw," at any rate, loses much of its deadliness, because judgment is not upset thereby. Volleying requires more accurate judgment, and is more difficult to attain, not only because it is quicker, but also because it is more difficult to modify. It is correspondingly more deadly in those who have accurately acquired it. A very deadly stroke is made when a ball is volleyed back direct quite straight at the opponent. The flight of the ball occupying very much the same position in the vertical and horizontal planes deprives the player of important data in forming a judgment, because, in its flight, the relationship of the ball to its surrounding objects is so very little altered; this constitutes a so-called "blind spot," analagous to a similar condition in cricket. This is so-called because for a moment the player is unable to form any accurate judgment as to the exact spot to which the ball is coming, with only a general impression that it is coming at him. Of course, knowledge that comes by experience conveys a correct impression to the expert, but those who do not come into this category have very great difficulty in estimating the flight of the ball. There are many little tricks that may upset the eye, such as pretending to make a great muscular effort in preparing to strike the ball, so that the player runs backwards to receive it, and then, by check only giving a very slight tap to the ball, with the result that the opponent has moved away from, instead of approaching, the place on which the ball pitches. However, enough has been said to point out that the man who becomes the greatest expert is one who not only sends the ball, when he is within reach of it, skimming over the net with deadly effect, but he who has wide perception of the various details that give an effective grasp of what is going on, even though he may not always be very deadly in his actual strokes, but adopting the tactics of a "stonewaller" can tire to death his opponent, until he can with certainty kill him outright.

Golf. Few games sound feebler when described than golf. Yet hitting a ball from hole to hole has engrossed the attention of more men and women than any other kind of sport. It is said of W. G. Grace, with what truth is not known, that when, as a middle-aged man, he took up golf, he wondered how it was he had wasted so many years over cricket. Yet, simple as the game sounds, it calls for the need of the eye in its every aspect to a very great degree, and getting the hole in the fewest number of strokes is merely proof of the man who has the best eye. It certainly is not a sport to be taken up by any fool, and the most important qualification that a man has for the game is the possession of a good brain. To take James Braid as an instance, anyone who knows him and has had the pleasure of conversing with him will recognize his great brain power and will know him to be a man who would have succeeded in almost any walk of life. As before said, the eye is required in every detail of the game, and for the normal two-eyed man there is especial need of the use of both eyes. "Keep your eye upon the ball" is a conventional phrase which some have interpreted into the meaning "Keep your master eye upon the ball." What it should really mean is "Keep your two eyes upon the ball," for in striking the ball the golfer has to make many estimations, and these estimations in a normal-sighted man can only be accurately made by the use of both eyes. The exact estimation of the distance of the ball from him which he wishes to strike with the club can only be readily made by the knowledge of the length of the club. This is obtained generally sub-consciously, partly by the estimation of the two eyes and partly by the sense of touch in grounding the club behind the ball. The next step is the co-ordination of the muscles in the swing in striking the ball truly. There are roughly two elements in this, what may be called the swing proper, namely, the movements of the hands, arms and shoulders, and the rotation of the body in the act of swinging, but there is also fixing the body, as it were, on pivots, so that the swing and stroke shall be played true on the ball. It would appear, at first, that there is only one pivot or fixed point, the feet, or more correctly, according to authorities, the left foot. but there are really two pivots of the swing, as a gate swings on its posts, namely, at the left foot below and at the second pivot at the point halfway between the two eyes at the upper end. This may seem at first thought a purely theoretical and problematical statement, but it is not really so. Probably, more depends upon this so-called fixed point than upon that of the foot. Supposing that the swing be perfectly correct and the fixed point of the foot perfectly steady, but if the other point, the eye point, which has been described as being a

point midway between the two eyes, moves an inch backwards or forwards to or from the ball or to any degree from side to side, the correctness of the swing will be of no avail. The ball will be sclaffed or topped and the correctness of the swing will be no protection against this. Actually then, the golfer swings his body from two fixed points, the left foot which gravity keeps in its place, and the other point, kept true by the knowledge of the distance of the ball by means of the degree of convergence of the two eyes upon it, and by the fixity of the eye muscles, for if the eyes are kept constantly held in the position of convergence on the ball and directed at the ball, the head will be kept perfectly rigid, both in the backward and forward plane, as well as in the lateral plane, because any movement of the head would demand compensatory movement of the eye muscles.

Looking now at the co-ordination required in the swing, though the eyes and feet may keep the body fixed, there is a great scope for error, if the muscles be not properly associated and co-ordinated, which may cause the ball to be missed. Therefore, the fixed position of the head and feet is actually of primary and essential importance. The writer has said essential, but this is not strictly true, because when anyone becomes extremely experienced and every act becomes practically a reflex one, the experienced golfer with his eyes bandaged, if only he can ground his club behind the ball, may strike the ball, absolutely correctly in driving, having really, in this case, fixed the eye point by means of his stance, through the intermediary of muscles of the body, instead of the eye. This, however, only means an enormously high degree of associated and co-ordinated act, so that it becomes practically a reflex that is originated by grounding the club behind the ball. The same sort of thing takes place when anyone, who has never held a club before, plays his first game. He relies upon the associated movements which have been developed from other things, such as cutting off the head of a daisy with a walking-stick, and so with the eyes trained in that way, he may play his first game surprisingly well, but such dependence soon becomes absolutely stale, and his second or third game demonstrates his incompetency. Now, the condition called pressing is often a source of failure at golf. This is a state of things that may be readily understood from what has been said before. The association of muscles is an extremely delicate form of balance and if, by desire to drive far, voluntary stimulus is given to certain muscles, muscles not subject to or beyond the power of the co-ordination centre, failure results. Judgment of distance in an approach shot requires much more than a mere control of strength it also means the selection of a special club and a special

way of striking the ball to produce the desired result, not merely a diminution of strength, but also the kind of stroke that produces a skying effect on the ball, in order that it may not travel far after it has pitched. As regards putting, rather different conditions prevail, and the judgments, though perhaps not of greater importance, are more delicate in degree, for exact direction becomes of even more importance than the degree of strength of the stroke. This too, however, if not of equal, is also of great importance, because only a small latitude of strength can be granted in a successful putt, but practically hardly any latitude can be allowed in the matter of direction. Now, in the act of putting the question of position must be considered, whether a modification of the drive or some special position shall be adopted. In the course of play special strokes may come on, such as chopping strokes and wrist and arm strokes, such as are used in getting balls out of bunkers and obstacles, but, in the ordinary and uneventful play, from the tee to the hole may be merely a series of modifications from the drive to the putt. But there are other forms of putting which are special and cannot be considered as a modification of the drive. Peculiar positions, etc., are taken up or a more pushing way of hitting adopted. This may be summed up in saying that when delicate estimations have to be made, either a very experienced and co-ordinated set of muscles have to be used, such as in ordinary driving, or few muscles,—in other words, the fewer muscles that have to be used the easier it is for the brain to co-ordinate the movement. For instance, if the body and the upper arm be kept perfectly still and merely the muscles of the fingers and the fore-arm be used, it is a much less complex job for the brain than if it had to co-ordinate a greater number of muscles. In the same way, those who putt by taking a purchase with the arm resting on one leg again eliminate the need of the use of certain groups of muscles. It would appear that in successful putting the effort of the golfer is directed to making the movement as simple as possible, so that the brain has an easier job in co-ordinating the muscles. What is needed is the conscious knowledge of the direction which the ball has to take, for the player cannot at the moment of striking make a direct observation. As mentioned in croquet, using the eyes in the horizontal plane would probably make it easier to aim, but such position with a golf club would be exceedingly awkward, counterbalancing, any advantage thereby gained, and probably no one uses that method in striking. Some in taking aim, walk up to the ball from behind and so impress themselves with a sub-conscious knowledge of the direction of the hole. Others, instead of estimating the direction to the hole, take a

point in the line of vision over which the ball should travel, if it is going truly, and aim at that point. Some, again, look at the ball when they are striking, some look at the hole, but it is almost universally accepted that, in order to be able to hit the ball as desired with the golf club, it is necessary to keep the eyes fixed on the ball for reasons which have been explained. In these questions of putting it is hard to say which is the best, for there is something to be said for all methods and the player is best at the one which he has practised and he is disposed to lay down the law to advocate that method. On theoretical grounds alone, the writer would be inclined to say that, as the importance of direction takes slight precedence over that of strength in contradistinction to driving and approaching, when strength takes precedence over direction, a different style rather than a modification would be better, for undoubtedly the less complicated, from the muscle point of view, is the act, so much the less difficult is its control. A word about the movements a player may go through with his knees and clubs. Of course, this may be mere imitation of a learner, or it may be the unlimbering of the muscles, so that all may be free, but the writer has before suggested and is inclined to think that he is correct, that it is a means of preventing the aim and the co-ordination of the muscles from becoming stale.

Billiards. For this game the highest physiological attributes of the eye are called into play. Judgment of distance and the distance of one ball from the other and the angle formed by the balls, or by the pocket and the ball, are matters of accurate brain judgment. It is not merely a matter of aim, which is not difficult under the favorable conditions of a billiard table, but of judgment of where to aim in order that the ball shall travel at the required angle. Among billiard players, a very great majority do not aim with one eye or the other, but with both, with the mental line of vision. Most will deny that this is the case, but it is only necessary to watch players when unnoticed to observe what is done, and the truth of the writer's observation will be apparent. On a billiard table practically only the horizontal plane has to be considered and therefore the lower the head is carried towards the cue the more is the judgment of the vertical plane eliminated. This, however, as the player becomes more experienced, becomes less necessary, and it may be that the player gradually omits to bring the chin so low. At the same time, though it may not be so necessary, habit and custom, in other words, educated muscle-sense, tend to preserve for the player the attitude he has adopted during learning. The writer believes it is true that Roberts, who has marvellous judgment from mere observation of the ball, and

whose muscle-sense obeys his judgment without the intervention of any special aim, stands upright and appears to hit the ball absolutely carelessly, but with astonishing accuracy. On the question of aim, too, he illustrates a point on which stress has been laid before, that after the aim has been taken, be it direct or purely by brain judgment, it is immaterial where the player looks when actually making the stroke. This is well illustrated when Roberts, at the moment of striking, will turn his head on one side and speak to a friend without impairing his accuracy. It is often argued as to which ball the player should fix his eyes, the object ball or the cue ball. Some good players strongly advocate one, other players the other, for an ordinary stroke. They cannot both be right that the principles they advocate are essential, but the explanation is that both are to a certain extent right, and that it is immaterial where the player looks, so long as he has practised it. This can be tested by anyone, by practising looking at the cloth between the two balls, after the aim has been taken, and then playing the stroke. It is probable that at first the player will play best with his gaze fixed where he has been accustomed to fix it, but he will be surprised to notice how little difference adopting another line of vision makes in the stroke, so long as he keeps his head still. When it is necessary to strike the ball on a particular spot, such as putting on side or screw, then it may be necessary to fix the cue ball in order to strike it accurately on the part required for the special purpose, and it is believed there is general agreement on this point. Referring to aim, there is no doubt that the player, as he becomes experienced, depends less and less on direct aim and more and more upon judgment, but it is very difficult to form a very definite idea as to the exact degree that is required. It is true that there are some who never advance from the direct aim, but they never become brilliant players. The use of ivory or composition balls, whose resistance varies and consequently the angle at which they come off, taxes brain judgment a good deal and upsets the mere aimer to a much greater extent than he who plays by judgment only.

Cricket. Almost every detail of cricket is regulated by the eye, bowling, batting, and fielding. To begin with the bowler, the bowler has a twofold object, in the first place to deliver the ball, as he desires, and secondly to conceal from the batsman the manner in which he is dealing with the ball. The writer does not know whether all bowlers fix their eyes on the wicket in bowling, but certainly an enormous majority do so. The ultimate goal of the ball is in all cases the wickets, except when the ball is bowled for the sake of a catch. Then he desires to deceive the batsman, either by the pace of the ball or

by the pitch of the ball, or by putting on a twist. In this latter case it is important to conceal from the batsman the nature of the twist which he is putting on. That excessive bowling produces staleness has been alluded to elsewhere, and overbowling, as staleness in this instance is called, is very apt to occur. The batsman's eye includes two objects, one, the perception of where the ball is going to pitch and how it is going to act after it has pitched; and two, the appropriate moment for hitting it in any particular stroke. It is very difficult to say exactly when the batsman's judgment is formed, but probably, as regards pitching, very soon after the ball has left the bowler's hand. By observation of the bowler's fingers and wrist, the batsman attempts to make up his mind exactly how the ball will behave after it has pitched. Then another question comes in, the state of the ground, as to whether the ball is likely to rise much or shoot, for if the batsman is not prepared for these eventualities, he is of course more readily taken by surprise when they occur. In recognizing the data that the eyes give him, the eyes may be used either in the horizontal plane or the vertical plane. The horizontal plane has come into increased use in recent years, and undoubtedly it should give the batsman a better conception of the behavior of the ball in the vertical plane than does the use of the vertical plane of the eyes. Still, many adhere to the old-fashioned way of using the vertical plane, and, though the data are not so good, probably by long experience and practice the resulting play may be as good as in the case of one who uses the horizontal plane. The nearer the ball pitches to the batsman, the more difficult is the estimate for him. Presumably, too, the more the ball comes to the leg stump, the more difficult is the estimation of its pitch, for the more it comes to the leg stump, i. e., along the line of vision, the more has the estimate of the pitch of the ball to be made in its vertical plane alone, but to the off and well to leg the batsman has the assistance of the horizontal plane as well. As before mentioned. the batsman forms an estimate of the flight of the ball very soon after it has left the bowler's hand, if he has correctly observed the behavior of the wrist and fingers—he even knows how it is going to behave before it has left. If there is any uncertainty as to the direction or the degree of twist, should there be any, he is obliged to form a fresh estimate after the pitch of the ball. Again, should the ball shoot, he is obliged to modify very quickly his preconceived estimation. But not only has the batsman to form an estimate of the behavior of the ball, but he has to make a judgment as to how best to deal with it and stimulate the co-ordinated centre to make an effective movement with the bat. This is a voluntary act; as the

batsman "gets his eye in," it becomes more a reflex and less a voluntary act, the better his eye is "in." There is a phrase often used by batsmen to account for the fall of the wickets or for missing the ball. It is that the "ball got on their blind spot," and this many have supposed is the moment when the image of the ball has literally fallen on the physiological blind spot of the eye. There is, of course, such a spot, but it has nothing whatever to do with this faulty estimate. There are at least two ways in which this so-called blind spot can be accounted for. One is merely a faulty estimate, the other is an absence of estimate. Now to illustrate the first way. The difference between the pitch of a half-volley and a "yorker," the writer understands, is only a slight one, and, if a ball has been well pitched up and a wrong estimate of its pitch has been made, it is easy to perceive how the ball can just pass beneath the bat in the act of striking. As to the second way, in the case of a well pitched ball, the batsman may play forward to the pitch of the ball, but if he has any doubt as to how the ball is going to behave, as to whether there is screw on it or not, he has to form a fresh judgment of the behavior of the ball after it has pitched. In that moment of time, in which he has thrown overboard the old judgment and before he has made a new judgment, there is an actual moment of mental blindness. The same sort of thing occurs when a ball shoots and the batsman has very rapidly to play back to a ball in order to leave time for the train of thought.

The wicket-keeper is a very interesting instance of judgment. He forms an estimate of where the ball is coming, as does the batsman, very soon after it leaves the bowler's hand, his estimate being corrected as the ball approaches him. His co-ordinated motor centre responds to the reflex of his estimate on the approach of the ball, Things must be in train some time before the ball reaches his hands, because, even though it be struck away, the associated centre works as if it had not been so and his hands come together as if he were receiving the ball, there not being sufficient time after the striking of the ball to inhibit the movements for catching it. In fielding, the player has again to form judgments as the ball approaches him, and in making a catch very delicate estimation has to be made. It is said that a catch is made by getting the master eye, the hands and the ball all in the same straight line. But, of course, this is not the case, for there never was greater need for the use of both eyes in the horizontal plane in judging the exact time and position in which the ball will reach the hands. Of course, it is the act of convergence on the ball that gives the necessary subconscious brain effect which stimu-

lates the various brain centres to execute correctly the catch. If one eye only be used, even though it be the master eye, one would lose the data from the act of convergence that is so necessary in correct performance. In throwing up the ball at the wicket, there is the same need that has been described in tennis and other games in co-ordinating the effect of the muscular movements with the line of vision. Wonderful rapidity in making an estimation or judgment is needed by those who field at point or slip, and a particular kind of temperament is required for these positions.

Shooting. On the subject of shooting there is much to be said, for in this sport the use of the eye is more disputed than anything else, but it must be remembered at the outset that there is more than one way of using the eyes in shooting. This should be clearly understood, for those who argue one way too often forget that they are not using a common standpoint. Gun-shooting and rifle-shooting usually represent two different kinds of shooting, but there are a few who do shoot with the rifle as with the gun. In the ordinary use of the gun, there are at least three different ways in which it is practised, and the object may be aimed at in at least two different ways, and, if a moving object, hit in at least two different ways. The object may be aligned with one eye along the midrif, or the gun may be pointed by judgment, that is, by the training of the muscle-sense, to bring it up true to the observed mark. This, although very few recognize the fact, is the procedure adopted by almost all trained shots, whereas one-eye alignment is supported as the ordinary procedure by a large number, including most, perhaps, who are looked upon as authorities, such as teachers at shooting-schools and so on. Now, in shooting at a fixed mark there are the following requirements, the estimation of the position and direction of the object, as bringing up the gun in the direction of the object, as making true the aim and the pulling of the trigger. The beginner takes each step separately, but when he becomes a trained shot all these steps merge into one or may merge into one. This is especially the case with a moving object. As the individual becomes trained, these steps automatically, as it were, merge into one, so that the very fact of seeing the object puts in motion the train of impulses which automatically excite each succeeding act instead of a voluntary impulse for each. In fact, a physiological train of action is set up by seeing the moving object. It is the training of this physiological power which takes place at the shooting-school or in the earlier attempts of the beginner. Each act is separately thought out and a brain impulse given for its performance. The object is aligned by the right eye, which, usually, is what is

called the master eye. Then, if it be a moving object, the gun is separately swung or chucked, and, when the gun is sufficiently in front of the moving object, then comes the deliberate act of pulling the trigger. Now, in the ordinary normal man, the estimation of the distance and position of an object is made by the use of both eyes. The gun is brought up in that direction and the beginner has to concentrate his attention upon his right eye instead of upon both, align the barrels at the moving mark, and execute the following manœuvres in sequence. With practice and experience the gun is brought up more and more truly to the object which is being fixed by the two eyes, so that the alignment is secured without the action, as it were, of the master eye, even although the master eye may, in consequence, take a position of alignment with the object. Automatically, when the swing has given the gun the correct position in front of the bird, the fact of the gun being in such position gives the impulse to the finger to pull the trigger. All this is really the training of the muscle-sense, which can be brought to a great pitch of perfection. Analogous training of muscle-sense can be developed in various ways. For instance, muscle sense is trained to a very high degree in the marvellous performances of acrobats, but the most familiar instance of the training of muscle-sense is in the training of a pianist. An experienced pianist, reading new music with his eyes fixed on the book, will strike correctly with his little finger a note down in the bass. In exactly the same way an experienced shot directs a gun at the desired object, although the fact that he is engrossed with the object prevents him analyzing the means which he is adopting. There are many ways of proving this practice. If a man holds a gun in his hands and looks at a mark with the intention of firing at it and if directly before he brings up his gun, he shuts his eyes, he will find that he has found the aim fairly accurately, seldom quite accurately, for all the time the gun is coming up, he is, under the usual circumstances, correcting his estimate of the aim. Another way in which Doyne considers he has practically proved this point is in the case of a very experienced trainer of shooting. The writer gave him spectacles with strong prisms in each eye, in order to make the object look about a yard to the left of where it really was, and he missed consecutively to the left. A little thought shows that this is conclusive evidence, for if he had brought the gun up and aligned the mark with the right eye through the prismatic glasses, he would have aligned it truly, because he would have seen the mark and the barrels under the same conditions and so would have brought the gun up true to the mark through the glasses. This would have been a yard to the left of where it actually was, and he would

have brought his gun up according to the estimate he had made and communicated to his muscle-sense. The writer has tried this experiment himself and the shot went, more or less universally, in the direction of the apparent position of the object. It will be frequently noticed that people, who are discovered to be, as it is called, left-eyed, in consequence of their bad shooting, although they have often shot for years, do not always miss, but are sometimes quite successful. At other times, especially when they are particularly anxious to shoot well, they invariably miss. The explanation of this is quite simple, according to the sequence of the development of a trained shot which the writer has above described. In these cases, the individual has trained his muscle-sense, and, as long as he uses merely muscle-sense and two-eyed fixation, he shoots to a greater or lesser degree truly, but if he becomes anxious to succeed he harks back to the earlier stage in his training, when he aligned with the barrels, and he picks up the alignment with the left eye instead of with the right. Consequently, he misses away widely to the left, whereas, if he were right-eyed, it would not make so much difference, but even in this case, it would make him much slower, because a greater length of time is required for associating different thought-out details. It is a common experience for a man to miss when he is particularly anxious to hit, and this splitting-up of the trained physiological process is responsible for making him slow. Of course, it is possible for a man to perpetuate the alignment and give a bigger swing or chuck in front to compensate for the slowness in time entailed by the process, but the fact of both eyes having to be used and the concentration of one eye after fixing the object with both is, in the process of training, very readily eliminated. As the writer has said before, there are different ways in which different people shoot, and some may perpetuate the lengthier process with which they have begun. Another manner in which a very few do shoot and sometimes even become fairly successful shots, is shooting at a fixed point in front of the object without swing. Of course, such a process is liable to enormous variation according to the latent period of the individual, for it depends on the accuracy of his estimate under all sorts of different conditions. For instance, in partridge shooting he would have to shoot at about thirty feet in front of the bird for a crossing shot, and this would be influenced very greatly by the strength of the wind impeding or aiding the flight of his shot. In fact, the condition is snap-shooting when a fixed point is shot at without swing or chuck. Binocular fixation and aligning with the mental eye is wonderfully illustrated by the remarks made by Payne Galwey in writing of the influence of the left eye in

trying to aim to the left. Such influence of the left eye is really the influence of binocular vision as compared with right-eyed vision and amounts to a sort of struggle of alignment by mental vision and the right eye. The advantage of binocular vision is not only speed, but also a better view of what is taking place in the direction of the object, for if the right eye only is being used a very large wedge is shut out beneath the object. If both eyes are used there is only a very small space completely occluded a little to the right, so that if the bird falls or flies downwards and the right eye is being used for alignment in fixing the object, the bird has to be continually re-sought and aligned as long as it is dropping in flight, whereas if the object is aligned by means of the mental eye, it is always in view.

Finally, it is beyond doubt that many people do shoot by alignment by muscle-sense, as, for instance, those who shoot from the right shoulder and are blind in the right eye. This fact establishes beyond any question the possibility of such alignment, and the only point for discussion is not whether it is done, but which is the most frequent method, and the writer has pointed out how involuntarily the trained shot falls into alignment by muscle-sense from one-eyed alignment. The following article, written by the author for *The Country Gentleman,* August 12th, 1911, illustrates the process which takes place in shooting.

"What exactly a man has done with his gun when he brings down the bird at which he has fired is a constant subject for discussion at the covert-side, and for argument in the sporting papers.

The question is a very complex one indeed, differing under different conditions, and not always constant under the same conditions. In my lecture I stated that I was only dealing with the trained shot, but now I propose to treat the subject briefly from the evolutionary point of view, showing how the normal-eyed learner, beginning with the use of one eye, develops the highest degree of what I call Eye, Eye being the product of the function of the special sense of sight and muscle-sense controlled by brain judgment.

There is no doubt whatever what a boy does when he first gets his new gun. He can describe it accurately, which is in contrast with the trained shot, who never can describe or knows what he has done. When a boy begins to shoot he brings the gun up to his shoulder, looks along the barrel with his right eye, and moves the gun until he brings the bead on to the mark at which he is going to fire. When he has got it in line he pulls the trigger. He has no need of muscle-sense or brain judgment, except in its most simple form. When, however, he shoots at moving marks at varying distances, another brain process has to be called into play. He has to form an estimate of how far off the object

is and how fast it is moving. Without entering into further explanation, it will be seen that the judgment of one depends upon the other. and it is obviously an important estimation that has to be made.''

Doyne now describes the physiological process by which the shooter forms an estimate of the distance of the object. The process resembles closely the principle of most range-finders. When an object is looked at, each eye is directed towards it; the nearer the object is the more have the eyes to converge upon it. This convergence is performed by the two muscles that pull the eyes inwards. The farther off an object is the less have these muscles to contract; the nearer it is the more they have to contract, and the brain estimates the distance of the object by the amount of contraction that these muscles have to perform. Very well, then; the shooter has for this purpose to make use of both eyes, and when he has done so, in this early stage of his evolution, he again acts in the way that he adopted when firing at a fixed mark, and, giving up binocular vision, he looks along the barrel with his right eye, bringing the bead to bear upon the object, and when he has made due allowance for the movement of the object he decides to pull the trigger, and for this purpose the impulse is sent down from the brain to the forefinger of the right hand.

''From the constant bringing of the gun up to a fixed mark or to a moving mark in this early stage of his education, another function is beginning to be developed—namely, muscle-sense. Then we find that by the action of both eyes he has to form an estimate of the distance of the object. Next, by muscle-sense, he brings the gun to his shoulder more or less in the direction of the object; then, looking along the barrel with his right eye he makes the aim true, and when he has made due allowance by 'swing' he deliberately pulls the trigger. This sounds a somewhat lengthy process, and so it is, and the beginner usually has very great difficulty in hitting the moving object. It will be easily understood that the means of shortening the process would be by grouping and associating the various acts together, and this is what actually happens in the evolution of the shooter.

''So far the estimation of distance and the muscle-sense in bringing the gun to the shoulder are separate acts, but they are quite early associated, so that the gun comes to the shoulder at the same moment that the estimation of distance is made. But this estimation has involved the use of both eyes, and for the aim the use of the right eye along the barrel alone is at this stage required, so the binocular performance of the eyes has been given up. After follows the separate voluntary act of pulling the trigger. Now, some shooters get no further than this, and they are recognized as slow and poking shots.

But the development of the shooter should and generally does proceed until the muscle-sense becomes so highly developed that it is blended with the aim. In other words, the gun comes up at once true—that is, parallel with the central visual line which represents the mental line of vision, the product of the two eyes which are both already at that time in use estimating distance and speed. Such a line is one drawn from a point midway between the eyes to the object fixed by the two eyes.

"It is here that mistakes and misunderstandings occur. The habit or action which as been hitherto adopted of aiming with the right eye will ensure that the shooter more or less adopts the same position as if he were aiming with the right eye. Therefore," continues Doyne, "the actual direction of the gun will be more or less in alignment with the right eye, although he is not using the right eye for that purpose, the alignment being made, as I have said, parallel with the mental line of vision, which is, as I have described, the product of both eyes. This blending of muscle sense in bringing up the gun with making the aim true to the mental line of vision and with the use of the eyes in judging distance, will not be a sudden definite step, but a gradual one, and, consequently, for the correction of aim the shooter may fall back upon his earlier right-eye alignment, especially at such times when he is particularly anxious to shoot well, or is nervous after missing several shots. Now, this dropping back to correction of aim by single-eye alignment will be interfered with, if the left eye happens to be the master eye, for the bead and the object will be the chief points in alignment; and if the left eye happens to be the master eye it may pick up the bead and the object instead of the right eye, the consequence being that the gun will be pointed far away to the left, whereas, if the right eye be the master eye, the going back to the single-eye alignment will merely tend to make the shooter slower or 'poke.' You will understand from this explanation how it is that the men with the left master eye do not always miss, but only when they become particularly anxious to make the aim true, and thus give up what they have unconsciously acquired, and do not know what they have acquired—i. e., aim by means of central visual line. It will be recalled that, when they do not care if they hit or miss, they may often shoot well, in which case they have not made the attempt to make the aim true by single-eye alignment, and it would also explain how it is that when the gun is cast off to the left master eye, a particular individual who happens to be left-eyed ceases to miss." See, also, **Marksmanship.**

Rifle shooting. Different from ordinary sporting-gun shooting.

Occasionally, a rifle is shot like a gun, but, as a rule, each shot is a separate process, and the rifle is aligned afresh when fired from the right shoulder each time by the right eye. Allowance has to be made for wind, weather, and time of day. There is a somewhat remarkable fact about this way of aiming. Supposing a man, without any anomaly of muscle balance, that is, without any of the error called heterophoria, aims with his right eye along the sights, making the fore-sight correspond with the back-sight, while he looks at a target with the left eye, he should score a bullseye, even though there be placed in front of the sights of the rifle a card or some object obstructing his view between the sights and the target. This result is due to the fact that the eyes take the same direction, so that, if he sees the target with one eye and the sights only with the other, truly co-ordinating the sights, the bullet will travel in the direction in which the other eye is looking. If he possesses any error of heterophoria, he is able to learn to obviate the effect of the error by looking above or below to the left or to the right of the target to the required degree. The amount, of course, has to be learned by experience. This entails keeping both eyes open in shooting, a rule that is almost universally unobserved, especially as shooting is generally practised under favorable conditions, when no extra help is needed like that which would be accorded by keeping both eyes open. The sort of help that is derived from shooting with both eyes open is avoidance of spasm of the focusing muscle and very great increase in the illumination of the object which is being fired at. For instance, if a hostile force were moving along under a hedge in the twilight, it might be quite possible to see it, if both eyes were open, whereas aligning it with one eye and the other shut, this would not be possible, these conditions being so seldom practised that the help of the second eye is not readily realized. All defects of focusing militate against accurate shooting, but they can be corrected by appropriate glasses for shooting, but herein lies a great danger, especially in long sight and astigmatism. In the case of long sight, directly the firer gets nervous or excited, there is a great liability to spasm of the focusing muscle. Astigmatism, too, is extremely likely to provoke such spasm of accommodation, which in its turn may produce heterophoria. Long sight, again, is liable to lead to all sorts of trouble, because it is seldom suspected, the sight being unaffected in low degrees. The sort of catastrophe that may suggest long-sightedess and spasm of accommodation is in shooting, for instance, in a series of seven shots, when the firer is liable to get five bulls or high scores for the first five shots and misses the last two. Of course, although the writer advocates the keeping of both

eyes open and the consequent use in rifle shooting of both eyes, he is quite prepared to admit that it is difficult to acquire, as it entails confusion and seeing two barrels instead of one, which may necessitate the closure of the eye for a moment to find out which are the true sights to be aligned, but after a time, a knowledge of this is readily acquired. In selecting men for the army, sufficient attention is not given to long sight in proportion to the attention which is lavished on short sight, for there is much greater danger to a soldier in the error which he does not recognize than in the error of which he is aware. Everyone can observe how much a short-sighted person makes out, even at a greater distance than that at which he can see clearly. Comparing, for example, short sight with long sight, the mischief of long sight is in people under 40 very often only manifest after exhausting conditions, such as a night out in the trenches without food, which would not affect in a special degree a short-sighted man, but might render quite hopeless a long-sighted man who, under normal conditions, is a really good shot. The writer believes that, so far from being encouraged to keep both eyes open in shooting, the soldier is actually taught to shut one, and, in his opinion, the greatest advance that can be made in preparing the soldier for warfare is the recognition of the principle above-mentioned.

One word on the requirements for big gun shooting, especially naval firing. The man whose duty lies here should be specially selected as having a short latent period. By "latent period" is meant the time it takes for a visual impression to reach the brain for its consideration and the length of time required to send a motor impulse down to the fingers to press the trigger or pull the lanyard. For instance, a man with a long latent period would have to pull the lanyard much sooner as the sights of the gun come on the mark when the ship is rolling than one whose latent period is short. In fact, the latent period is a detail of some importance which is not sufficiently regarded in selecting gunners. The latent period varies, too, under different conditions. It is lengthened by alcohol or muscular exhaustion, and shortened by tea or coffee, and it can be easily understood that its influence is continually altered. See, also, p. 7600, Vol. X of this *Encyclopedia*.

Fishing. In this sport the importance of recognizing the character of the water that is going to be fished, and the place where the catch is most likely to be made, is considerable. These are seen with the eyes, but perceived by knowledge and experience of the habits and ways of fish. The frothy backwater of the rushing stream, beneath the rocky bank or just under the rocks, where experience knows the

wily trout will be lying, are places which would not be chosen by an inexperienced fisher unless they were pointed out to him. All this is easily recognized without being further indicated. But, to be able to throw a fly many yards off, exactly on the spot desired, even under adverse conditions of wind and stream, needs peculiar judgment of eye. The fisher fixes his eye on the spot on which he wishes to cast his fly, and with the movements of the arms and hands he is able to give the impulse to yards of line, in order to land the fly almost on the exact spot he has selected. On consideration, this is one of the most marvellous co-ordinations of hand and eye, because it means such intimate knowledge of the swing of the rod and the impulse which it is capable of giving. People often talk of striking the fish; of course, this may be all very well with sluggish fish and eels, which swallow and suck the bait, but in trout fishing a trout is never really hooked except accidentally in this way, but, like salmon, he hooks himself, and the so-called striking is merely taking up the slack of the line, in order that he may not repudiate the hook. In playing a salmon a good deal of the eye is required, in order to make the rod give when the salmon jumps, in keeping a taut line, which is so important in making sure of the fish.

Sporotrichosis of the eye. An occasional reference to this infection has been made in this *Encyclopedia*. See, e. g., p. 6984, Vol. IX and p. 3058, Vol. IV. It is now proposed to discuss the subject in its entirety.

Since Schenck first described the disease in 1898, some 70 to 80 cases of sporotrichosis have been reported to 1911, during which time it has been known to attack the skin of the lids, or the conjunctiva, in but six cases. The first case in which the ocular conjunctiva was the seat of the affection and the first example of ocular sporotrichosis reported in America is that of Harold Gifford. See following pages.

As has been pointed out many times the disease occurs in a variety of forms, but in the most common one, tuberculosyphiloid-looking nodules form in or beneath the skin, become red or purple as they increase in size; the skin over them gets thin and the granulations break through and slow ulcers form, from between the granulations of which a little pus can be squeezed. Along the line of the lymph channels small abscesses and fistulæ lined with granulations not infrequently develop. Besides the skin, the mucous membranes, lungs, muscles, bones, and tendons have been affected. Dor has reported a single case in which rather large abscesses developed. General sepsis occurs rarely. Pathologically, the granulation tissue formed has some characteristics of both tuberculosis and syphilis. Potassium iodid in doses of 2 to 4 grams daily seems to be a specific for the disease.

The germ of sporotrichosis can be found only exceptionally by a direct examination of the pus, but on maltose-glucose, or glycerin-agar, on some blood serums, and the greatest variety of vegetables, it grows readily at room-temperatures, while at 37° C. some races grow readily and others only sparingly or not at all. The sporothrix is evidently only incidentally pathogenic. De Beurmann and Gougerot have found it growing on various plants, and at times it seems to lead a harmless, saprophytic life in the buccal cavity. In the common lower animals it is only moderately pathogenic except in the case of mice, which are rapidly killed by it.

Morax and Carlotti (*Annales d'Oculist.*, June, 1908; review in *Oph. Review*, p. 278, Sept. 1908) were among the first to speak especially of the eye symptoms. They point out that Schenk first isolated, from a case of multiple subcutaneous abscesses, an organism which he recognized as belonging to the class known to botanists as sporotrices. In 1900 a similar case was reported by two American observers. Later, de Beurmann carefully investigated and described a fairly long series of cases of this nature, and it is to his monographs that we owe most of our knowledge of what is still a very rare affection.

Several clinical varieties are known: the *lymphangitic*, in which, after an incubation of one to three months, there appears in the region of some superficial wound a cutaneous abscess, rapidly followed by nodules along the course of neighboring lymphatic trunks; the *multiple disseminated* subcutaneous abscess; the *dermic* or *epidermic* infiltration without involvement of lymphatics; and, lastly, that in which the lesion occurs on a mucous surface.

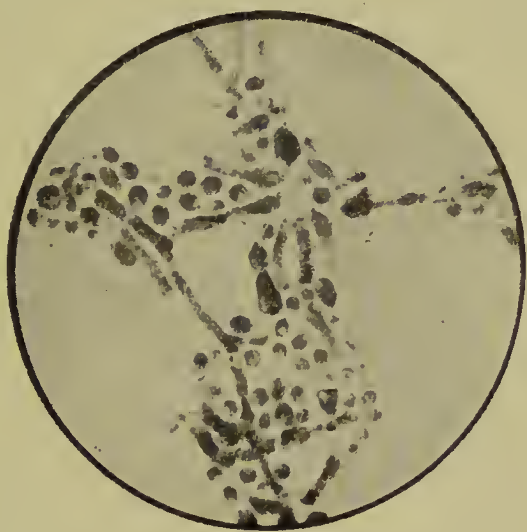
The case reported by Morax and Carlotti belonged clearly to the first of the types above mentioned, and had its point of origin in the free border of the eyelid.

A man of 70, apparently in good health, except for a certain degree of anemia and a tendency to acne about the nose and forehead, presented the following condition of his left eye. The upper lid in its whole length was moderately swollen to a distance of 6 or 7 mm. from the free border, the swelling having a purplish tint; along the upper margin of the swelling, and included within it, ran a curved line of small, yellowish elevations indicating the situation of subcutaneous abscesses; among the roots of the lashes were crusts of dried exudation covering several small longitudinal ulcers. The most peculiar feature was a lymphatic trunk, as big as a pipe-stem, which ran from the outer palpebral commissure in a sinuous course towards the preauricular and sub-maxillary glands. The skin over it was slightly

rosy and at one point showed the yellowish tint of a focus of suppuration. The pre-auricular gland was the size of a large almond; that on the angle of the jaw was nearly as large and was adherent to the bone; the sub-maxillary gland was slightly affected.

Another peculiarity of the affection was the apparent indifference of the tissues towards their uninvited guests; of pain there was none; the only symptoms complained of were slight tenderness on pressure and slight drooping of the upper lid. The condition had been present without much change for several weeks. No history of injury was obtained.

Smears were taken, with due precautions, from the ulcers, and pus was drawn by a capillary tube from one of the abscesses; these were stained by dilute fuchsin, by the method of Giemsa and by the method



Stained Agar Culture of Sporotrichosis from Ocular Conjunctiva, x 1,000. (Gifford.)

of Gram; no evidence whatever of the presence of micro-organisms was obtained by any of these methods, and the result was the same on repeated trials.

The case was different when cultural methods were employed. After three days in the stove at a temperature of 36°C., and with a day and a half at the temperature of the room, colonies appeared in abundance on the culture media, white at first, but, as they grew and thickened, becoming brownish or chocolate-colored. The medium on which they grew most easily was glycerinated carrot.

Under the microscope these growths were found to consist of ramifying mycelial tubules, septate, with branchlets coming off at right angles bearing clumps or rosettes of ovoid grains at their extremities, the conidia or fructification of the mould.

Inoculation experiments gave a cutaneous ulcerative lesion in mice and rabbits, from which characteristic spore forms could be obtained, while, in guinea pigs, no effect followed.

As soon as the presence of sporothrix was demonstrated the patient was given iodide of potassium in doses of 2 grammes per diem (subsequently raised to 3) without any local treatment being employed. Four days later he returned with the lesions manifestly improved. The lymphatic cord was still present, but when punctured and the contents inoculated on culture media the only growth obtained was one of staphylococci; it seemed that the pathogenic parasite had al-

Probable Sporotrichosis of the Eyelid, possibly Starting from the Tear-sac. (Gifford.)

ready succumbed under the influence of the iodide and that the staphylococci had developed secondarily in its place. In three weeks the ulcers were healed and the glands were mobile and half their former size; and before long the cure was complete.

The outward aspect of the lesions might have raised the question of syphilis or tubercle, although there was none of the undermining of induration associated with the former, none of the undermining of the skin, the large pale granulations of the latter; the result of the bacteriological examination, however, was unequivocal, and led the way to the speedy cure of an affection which might otherwise have proved disastrous.

In the *Annales d'Oculistique*, p. 65, August, 1910, four additional

papers on ocular sporotrichosis were presented and these, again, were carefully reviewed by Bishop Harman in the *Ophthalmic Review* for May, 1911. The reviewer abstracts them in the following order: 1. Jeanselme and Paulard describe a case of severe infection in a rag-picker æt. 46 years. He was under surgical care for generalized "gummata," when the left eye developed signs of typical acute iritis of the gummatous type. No part of the body, except apparently the viscera, escaped the invasion, nodules were found over the trunk,

Probable Sporotrichosis of the Eyelid.
Note the nodular lymphatic trunk from the palpebral Fissure toward the Ear.
(Gifford.)

limbs, bones, genital organs, and in the lymphatics. There was neither pain or symptoms of general disturbance but the right leg was so badly disorganized that it had to be amputated. The Wassermann reaction was negative. Large doses of iodide of potassium effected a cure of the general condition. One of the subcutaneous gummata was excised. Microscopically it showed a firm outer wall and a diffluent centre. Microscopically it presented the structure of a typical "tubercle" or granuloma. Staining did not show any parasite, but by cultures a sporothrix that did not conform exactly to any known variety was found in all the usual media. General inoculation ex-

periments were performed on white rats and the gummatous nodules were reproduced in myriads in all parts of the body, peritoneum included.

2. Morax and Cruchaudeau's case occurred in a woman æt. 22, nurse to a chemist. She suddenly developed a swollen left lower lid, lachrymation and symptoms of conjunctivitis. The pre-auricular gland was as large as a hazel-nut and tender. The affected lid was

Culture of Sporotrichosis on Lactose-agar.
Fourteen days old at room temperature. (Gifford.)

thickened as though it contained many chalazia. The mucosa was a deep-red and it was studded with raised circular areas, which interlocked, and were made up of numerous small ulcerated follicles of a yellowish or yellowish-grey color, covered with an easily lifted greyish pellicle. The secretion was gummatous and not adherent to the conjunctiva.

The condition suggested either a tuberculous infection, or even multiple chancres undergoing erosion.

Examination of scrapings and of the secretion by the ultramicroscope revealed nothing, and stained specimens showed no organisms. Cultures produced typical colonies of organisms presenting all the characters of the sporotrichum Beurmanni.

Treatment was carried out vigorously for the space of four months with complete success, only the adenitis was tardy in decline.

Large doses of iodide of potassium were given internally (at first 1 gramme and later 2 grammes daily) and an iodine lotion 8 in 300 was employed locally.

3. E. Velter's case occurred in a man æt. 52 years. He complained of a sensation as of a nail sticking in the outer corner of his right eye of three weeks duration. A small cold abscess was found pushing

Culture of Sporotrichosis on Glucose-agar.
Fourteen days old at room temperature. (Gifford.)

up from the outer wall of the orbit under the extremity of the lower lid. There was no tenderness, no conjunctivitis but some chemosis, no exophthalmos or limitation of ocular movements.

The swelling was incised, and some yellowish-brown, viscid pus was squeezed out. A probe showed that the wall of the orbit was eroded over an area 2 cm. in circumference and depth. The wound was drained. Examination of the pus was negative, cultures were positive for a sporotrix which reacted in all respects as the organism of Beurmann. The man was given 2 grammes of iodide of potassium daily, but he was irregular in his attendance at hospital, so that after about

six weeks the sinus was still open, bare bone could be felt and some fresh nodules had formed in the lids. The man then disappeared so that the end of the case is unknown.

4. Attilio Fava carried out a series of inoculations of the sporotrichum Beurmanni in the eyes of rabbits. He hoped to imitate those primary ocular lesions which had the greater interest to them. Earlier workers had used more susceptible animals like the rat, cat and dog, and got generalized infections. (1). Injection of emulsions into the subconjunctival tissues produced typical yellow gummata just like those seen in man. There was no adenitis or general symptoms. Incubation period 12 to 18 days. (2). Injection into the laminæ of the cornea produced interstitial gummata which soon became vascular,

Unstained Agar Culture of Sporotrichosis from the Ocular Conjunctiva, x 1,000. (Gifford.)

but never ulcerated. They perforated Descemet's membrane and produced iritis. Pure cultures were obtained from the aqueous. Incubation period 12 to 14 days. (3). Injection into the anterior chamber produced severe gummatous iritis in 12 days. (4). Injection into the vitreous body caused serious damage to the deep membranes and the vitreous, but the disorganization was less rapid than when other and even non-pathogenic organism such as the hay bacillus were inoculated.

In every case the organism was recovered in culture, but no organisms were found in the inoculated vitreous.

They noted rape-seed shaped bodies in the coats of the iris and on the surface membrane interlaced filaments which stained with Gram and penetrated into the superficial layers.

Gifford's case was that of a housemaid aged 18. She noticed her

left eye getting red about two months before the writer saw her. In the course of two weeks the disease developed to approximately the condition shown in the photograph. The young woman was fairly healthy, with nothing of special moment in the history. She attributed the trouble to having an upper tooth pulled on the left side, stating that the eye began to feel sore the next day. Gifford found the right eye normal, the left eye slightly irritated and watery; the tarsal conjunctiva and retro-tarsal folds were slightly congested and the ocular conjunctiva presented a somewhat crescentic thickening, reaching from slightly above the equator at the inner side of the cornea around below the cornea to a point ⅛-inch above the horizontal meridian at the outer side of the cornea. At its broadest portion below the cornea, it was about ¼-inch across, tapering out to the somewhat blunt extremities, between which and the corneal margin there was a narrow strip of normal conjunctiva. The thickening was rather smooth and light-red at its broadest portion, but at the extremities it was nodulated with lumps from 1/16 to 3/32-inch in diameter, and presented the general appearance of a retro-tarsal fold in a case of moderately gelatinous trachoma. No perceptible swelling of preauricular or cervical glands was present, but about an inch from the outer commissure a subcutaneous lump about the size of a small pea could be felt. One of the nodules down and out was yellowish, and contained a semi-fluid substance from which cultures were made on serum and agar-agar. These, left at room-temperature, showed after several days, a scanty but characteristic growth in pure culture, of the sporotrichum of the de Beurmann type. A second culture made from a nodule higher up on the ocular conjunctiva two weeks later gave a similar result. The girl was put upon iodid of potash, 20 drops of the saturated solution three times a day; and after two weeks the whole thickening was a trifle smaller, but at the extremities of the thickening there were several nodules slightly lighter colored in the center and containing a little serous fluid substance, which again gave a pure culture of the sporotrichum. When last seen the growth had diminished greatly in extent.

Although this is the only case in which the writer has been able to demonstrate the presence of the sporotrichosis germ yet he believes he has, in past years, seen five other cases of the same nature. One of these patients was a girl of four years, who was brought to him Jan. 30, 1906, with the story that the parents had noticed a growth on the right lower lid since the preceding Christmas, showing first in a small pimple in the outer third of the lid, and growing slowly but steadily thereafter. No history of injury was given. The left eye and

lids were normal, but the outer 3/5 of the right lower lid was covered from the ciliary border downward with a rough mass of granulations elevated ⅛-inch above the surface, ¼-inch broad at its outer extremity, and about ⅛-inch broad at the inner extremity. The granulations were of a reddish-grey, covered partly with thin crusts. The skin around it was normal except at the outer extremity, where there was a patch about ¼-inch square, purplish-red. From this a faint, interrupted reddish streak ran out along an irregularly thickened line of tissue to a swelling ½-inch in diameter, showing deep-purplish streaks and slight fluctuation half way between the ear and the eye. The growth was easily scraped away with a sharp spoon and the discolored skin at the outer commissure was found to cover a similar mass of granulations. These were also scraped out and the whole area cauterized with the Paquelin. The swelling over the zygoma was opened and found to contain the same sort of granulations with a slight amount of pus. This was all scraped out, leaving a hole ¾-inch in diameter by ¼-inch deep. This was filled with iodoform powder.

The pus and granulations were examined for tubercle bacilli and blastomycosis with negative results. The girl was sent home in apparently good condition, but returned in about six weeks with another swelling over the right malar bone. This was found to contain a little pus and a mass of granulations. It was cleaned out and filled with iodoform powder, and the iodid of potash was continued at home. She made a perfect recovery, and her mother reported in the spring of 1910 that she had had no further trouble.

The second case, very similar to the preceding, was that of a boy of 10 years, who for some time had noticed a swelling on the left lower lid. The examination showed two elevated areas of rough granulation tissue, covered with slight crusts, one of these just below the lashes, ¼ inch long, and another 3/32 inch below this, twice as long, both about ⅛ inch in width. About an inch from the outer canthus there was a swelling ¼ inch in diameter, slightly red on the surface, and ¾ inch farther out toward the ear another reddish swelling, ¾ inch in diameter. These both showed indistinct fluctuation. The masses of granulation on the lids were scraped away and burned with the Paquelin cautery and covered with Thiersch flaps. The swellings over the cheek were opened and found to contain a little pus and masses of granulations. These were scraped out and the cavities filled with iodoform. Four or five x-ray treatments were given in the next ten days and, although the larger Thiersch flap did not heal on, the patient looked so well that he was sent home. A letter from

his mother received May 29, 1910, a year after he went home, says that he had no further trouble.

The third case is that of Mrs. S. H., aged 22, with a good personal and family history. For four or five months she had noticed a growth below the left eye. It increased slowly in size and, although purplish-red in color, the surface was smooth. In the inner half of the left lower lid there was a mass of granulation tissue ¼ inch in diameter, raised rather more than ⅛ inch, covered with a thin crust. From this a purplish-red mass, covered with very thin skin, ran up to the bridge of the nose at the inner commissure. There was absolutely no history of lachrymal trouble; the conjunctiva was normal and the duct patent. Under cocain the granulations were scraped out and followed up under the skin to the bridge of the nose. An iodoform dressing was applied; the patient was given iodid of potash—just how much is not noted—and made a complete recovery.

The fourth case of this class was a boy of 4½ years, whose parents noticed a reddish lump growing in the right lower lid about January 1, 1909. About the same time a painful lump appeared near the angle of the right jaw; the tumor in the lid increased slowly, but caused no discomfort. He was brought to Gifford March 10, 1909.

The eye was normal, but at the inner side of the right lower lid, an inch below the caruncle, there was a reddish elevation extending obliquely for a distance of about five-eights of an inch, and about ¼ inch in width at its widest part. This was dark-red, elevated ⅛ inch, the surface covered with coarse elevations 1/16 to ⅛ inch in diameter. Here the epidermis was broken down; the rest of the tumor was covered with smooth, thin skin. Squeezing on the neighboring tissues expressed a little thin pus; there was no positive connection with the tear-sac, but the pus looked as though mixed with tears. The eye was not watery and did not show any signs of dacryocystitis; and liquid could be syringed freely from tear-point to nose. The glands below the angle of the right jaw were considerably enlarged, but no other enlargement existed on the face between the eye and the jaw-angle. The child was perfectly healthy in other respects; there was no history of trauma. The tumor was scraped away and the child sent home to take potassic iodid; but as, after three or four weeks, the growth showed a decided tendency to return, the child was brought back and the operation repeated, after which, under 15 to 40 grains of potassic iodid a day, a complete recovery ensued, except for a minute fistula in the scar, from which a little water comes when the boy has a cold.

While the lack of bacteriologic evidence prevents definitely classing

these cases as sporotrichosis, but as they were not tuberculosis nor syphilis, and the microscope showed no signs of blastomycosis, they can hardly have been anything else.

The *resemblance of the lesions of this disease with those of the more common diseases, syphilis and tuberculosis,* is undoubtedly responsible for the failure to make a correct diagnosis in a good many cases. Chaillous (*Oph. Year-Book,* p. 408, 1912) reports a case in which the ocular lesion was suggestive of cancer, and was treated with radium exposures without benefit. The patient was a woman of 71, and the chronic ulcer, of two years' standing, involved the margin of the lower lid where it had caused extensive destruction of tissue and ectropion. Other gummatous swellings were found on examination, and the microscope revealed the presence of the sporotrichum. The specific treatment with potassium iodid produced prompt improvement.

In most of the recorded cases ocular sporotrichosis has been secondary to lesions elsewhere. To reproduce experimentally similar conditions, Bourdier injected the sporotrichum Beurmanni into the carotid artery of a dog. Twenty-one days later a sluggish iritis occurred, with development of two gummatous swellings in the iris, and diffuse infiltration of the lower part of the cornea. The corneal infiltration become complete, reaching a maximum in about a week, after which it gradually cleared up.

In the case reported by W. H. Wilder and C. P. McCullough (*Journ. Am. Med. Assocn.* p. 1156, April 11, 1914) the external ocular tissues were fully infected and complete recovery did not occur for several months. When first seen the patient (a student who had been working in the laboratory with cultures of various strains of sporothrix, and on several occasions small capillary pipets containing emulsion of the organism had been broken at a distance of 8 or 10 inches from the face) noticed a soreness of both eyes, together with photophobia and a sensation as if a foreign body was under the lids. The following morning the lids were slightly swollen, the pain was increased and the surrounding lymph-glands were quite tender on pressure.

The general condition was good; there was no fever. Leukocyte-count was 9,000. The pain, swelling of the eyelids and photophobia had increased. The conjunctiva of the lids of both eyes was reddened and so swollen that the fornix rolled out in a mass when the lower lids were everted. In addition there were present on the palpebral conjunctiva and also on that of the fornices several grayish-yellow, slightly elevated spots varying in size from 0.5 to 3 mm. in diameter,

from some of which the covering epithelium had been cast off so that they seemed like small ulcers. Numerous follicles presented in other portions of the conjunctiva. Secretion was rather scanty, and an examination of a smear made from gentle scraping over the spots and the conjunctiva, stained with alkaline methyl-blue, showed no organisms, but numerous pus-cells. The next day scrapings were taken from the shallow ulcers and aërobic and anaërobic cultures were made. Potassium iodid, 10 grains three times daily, was given. The eyes were washed out several times daily with a solution of oxycyanid of mercury, 1:4,000.

Another addition to the rather numerous examples of this infection is reported by A. J. Bedell (*Ann. Ophthal.,* October, 1914). It occurred in a man of 49 and had lasted two years. The skin of the right eyelids was congested, and there was an irregular conjunctival mass 7x5x2 mm. to the nasal side of the upper right lid, extending 2 mm. beyond the ciliary margin. It looked like ordinary granulation tissue. The entire palpebral conjunctiva was congested, with many discrete follicles and numerous small ulcerating points which were shallow, yellowish-gray areas. The inner half of the bulbar conjunctiva was also congested, with several enlarged follicles. The caruncular fold was three times its normal thickness. Both puncta were prominent and dilated, and the inner canthus flooded with yellow, somewhat tenacious mucopus. Pressure over the sac caused no regurgitation. The corneal epithelium was lost over an irregular (4 mm.) area on the nasal side. No fundus lesion. Vision 20/LXXX.

Treatment consisted in removal of the conjunctival granulations, opening ducts and sac and the removal of five firm, brown concretions therefrom, curettment of sac, painting entire conjunctival sac daily with tincture of iodine. Internally iodide of potassium in 2 grain doses was given three times daily.

Recovery was uneventful, the eye healing in 53 days. The sporotrichosis organism was composed of a branching spore-bearing mycelium which was septate and granular, together with fusiform bodies of uncertain origin. The spores were commonly isolated and attached to the mycelium by a short and thin sterigma. It was Gram-negative.

In the account given of this infection by Gougerot (*Med. Press and Circular,* Oct. 7, 1914) he advises that in all cases which suggest syphilis, tuberculosis, or some chronic pyogenous infection, such as Parinaud's conjunctivitis, it is a good rule to bear the possibility of sporotrichosis in mind. It is often possible to diagnose the affection clinically on the strength of certain signs, given below, the importance of which has been established by Gougerot on many occasions.—A

large number of lesions or the extreme severity of any one lesion contrasting with the excellent state of the general health. Onset of the lesions in the form of an indurated nodule slowly degenerating into an abscess. Partial, cupuliform softening ulcers, usually narrow, enlarging secondarily. Irregular livid edges, almost always undermined, with pockets in which pus accumulates. Contrast between the small area of the ulcer and the extent of breaking-down gumma. The co-existence of several apertures or two contiguous ulcers adjacent to the same gumma and the persistence between the two ulcers of a slender bridge of bluish skin. The pus is viscid or the serous exudation citron-yellow. In spite of the persistence of the abscess, cicatrization takes place beneath the thinned skin. The cicatrices are flat, either narrow or wide, supple, with uneven edges often dentated with imperfectly adherent lappets of skin with a brownish halo. Then, too, there is rarely any glandular enlargement. The lesions retrogress under the influence of the iodine treatment, but recur if this treatment be suspended too soon. Lastly, the extraordinary mixture of different lesions: tuberculoid, syphiloid, ecthymatous, etc.

The positive diagnosis of sporotrichosis is made by cultivation of the fungus on glucose-agar or by recourse to the serum test. Gougerot believes the best medium to be peptonized glucose-agar, with the incubation carried out at room temperature. It is even unnecessary to resort to a microscopical examination, since so characteristic are the appearances that the naked-eye aspect of the culture is enough for recognition. Three tubes are inoculated, each with one-half to one cubic centimetre of pus, and left at the temperature of the room. In the case of closed lesions, such as synovitis, the pus is obtained by aspiration. Colonies of sporotrichum make their appearance between the fourth and the twelfth day, and at first they are brown and then of chocolate color. They can be recognized by their color and wrinkling, as well as by the brownish halo that surrounds them. Nobody who has once seen a typical culture of the sporotrichum will have any difficulty in again identifying it. If an earlier diagnosis be advisable, such may be made towards the close of the second day after inoculation, by examining with a low power microscope the colonies formed between the tube and the medium. The detection of threadlike filaments renders diagnosis certain.

Sporotrichum Beurmanni. The organism responsible for most cases of human *sporotrichosis*, (q. v.).

Spot, Black. A central area described by Fuchs, occasionally seen in high degrees of myopia, (q. v.).

Spot, Blind. The area corresponding to the optic nerve entrance. See p. 1205, Vol. II of this *Encyclopedia.*

Spot, Cherry-red. A red spot seen on the retina of each eye in the region of the macula lutea in amaurotic family idiocy. Called also Tay's sign.

Spot, Corneal. An opacity of the cornea.

Spot, Green. Both Stargardt (*Zeitschr. f. Augenheilk.,* April, 1912) and Harrison Butler have made a similar observation of this very rare affection, viz., a green spot at the macular region, which Butler considered as a formation of a hole and changed coloring matter of the blood. His case occurred in a woman, aged 28, with myopia of 17.00 D., annular broad staphyloma, diffuse atrophy of the fundus, which contained very little pigment, except at the macula. In the center of the macula was an irregular quadrangular patch, 1½ disc diameters high and wide, of emerald-green color. It was sharply defined, chiefly by a seam of fine black pigment, and corresponded in intensity and luster to the tapetum of animals. It was neither depressed nor elevated, was traversed by two small retinal vessels, and the choroid under it was preserved, since choroidal vessels could be seen submerging under it and emerging from it at the other side. There were no hemorrhages. A formation of a hole could be excluded, on account of the preserved retinal vessels, but from the central scotoma a destruction of the cones and rods could be inferred

Stargardt considers the affection analogous to the central black spot in myopia, described by Fuchs, and, as found anatomically by Lehmus, produced by a proliferation of pigment epithelium, due to a progressive nutritive disturbance. The green color results from a proliferation of the pigment epithelium which at the same time loses the greatest portion of its pigment. The proliferated cell mass acts in the same sense as the tapetum cellulosum of carnivorous animals, which, as an opaque medium, converts the black color into blue, in other words green, probably in combination with phenomena of interference. The blood, circulating in the choroid, gave an admixture of yellowish-red to the bluish tint and thus produced the green color. See, also, p. 1007, Vol. II, of this *Encyclopedia.*

Spot-lens. A condenser having a permanent axial stop.

Spot of Mariotte. See **Blind spot.**

Spot of Sömmerring. Macula lutea.

Spots, Bitot's. Shiny, gray, triangular areas on the cornea, consisting of flaky masses of dried epithelium and microörganisms. See **Xerosis corneæ,** as well as **Military surgery of the eye,** about two-thirds towards the end of the latter.

Spots, Eye. See **Worms, Eyes of**; also p. 8486, Vol. XI, and **Comparative ophthalmology.**

Spots, Flame. Large hemorrhagic spots in the eye-ground.

Spots, Fuchs' pigment. See **Pigment spots, Fuchs'**, p. 10223, Vol. XIII of this *Encyclopedia.*

Spot, Soemmering's. The macula lutea.

Spots, Roth's. White spots on the retina in septic retinitis.

Spots, v. Graefe's. Certain spots near the supraorbital foramen, or over the vertebras, which, when pressed upon, cause a sudden relaxation of the spasm of the eyelids in cases of blepharofacial spasm.

Spot, Tay's. A red spot (the choroid) surrounded by a white circle seen through the fovea centralis in amaurotic idiocy.

Spot, Yellow. The macula lutea.

Spraying solutions and mixtures. The employment of ice water as well as very hot water in this way is effective in ocular diseases associated with pain and blepharospasm—especially in the acute phlyctenular diseases of childhood.

T. H. Claiborne (Wood's *System of Ophthalm. Therapeutics,* p. 66) states that he has had rapid and satisfactory results, especially in the treatment of *acute catarrhal infections of the eye* by the judicious use of eye sprays. He trims the eye-lashes and allows a few drops of a 2-grain-to-the-ounce solution of silver nitrate to roll over the exposed mucous membrane, then sprays thoroughly with a solution of cocain, about ¼ of a medicine dropper full of a 2 to 4 per cent. solution and about 15-30 drops of borolyptol to an ordinary spray-tube of water. In the summer he uses ice water and in the winter warm applications. He then instils a drop of adrenalin chlor. 1-1000. At times he substitutes (particularly in women) 1 gr. to the ounce of nitrate of silver, and in very sensitive cases uses only the borolyptol, cocain and adrenalin, supplementing this with appropriate treatment at home. To many people the spray is delightful; to others it is disagreeable.

Claiborne also prescribes a spray for home use—which in nervous people is easier than to use drops. He tells the patient to pull the lower lid well over the eyeball and look up while some one else sprays the following into the cul-de-sac freely 3 or 4 times a day: Cocain. hydrochlor. gr. i; Sodii bicarb.; Sodii chlorid. āā gr. v; Sol. adrenalinc chlorid. (1:1000) fl. ʒi; Aquæ dest. ad., fl ℥i.

Claiborne uses the above as adjuvants in all cases of conjunctivitis, but finds the results most brilliant in acute catarrh—particularly in "pinkeye."

Sprays. Nebullizers. The Editor *(System of Ophthalm. Therapeutics,* p. 106) has remarked how strange it is that these appliances, so use-

ful in the throat and nose, should be so little employed in ophthalmic practice. Perhaps the difficulty experienced by the patient, who cannot see precisely what he is doing during the performance, may have something to do with this unpopularity. From time to time there appear on the market ingenious devices for the purpose, but they do not have a ready sale. He has elsewhere given the favorable experience of Claiborne (see *supra*) in the use of certain spraying solutions and suggests that this method be given a trial (with an ordinary water nebulizer) in office practice especially. For home treatment there are on the market a number of pocket sprays, useful for applying evaporating lotions and collyria.

Spring catarrh. See **Conjunctivitis, Vernal,** p. 3170, Vol. V, and **Vernal conjunctivitis** in this *Encyclopedia.* In addition to the matter under these captions it may be noted that Axenfeld presented a report on this subject to the *Soc. Franç. d'Ophtalmol.* in 1907 in which a complete account to date of our knowledge of this curious disease is given. A review of this work will be found on p. 173, June, 1908, of the *Ophthalmic Review.*

Speaking generally the report concludes that the palpebral growths in spring catarrh are the result of an inflammation of the subconjunctival connective tissue, with secondary proliferation of the epithelium. In the bulbar proliferations the epithelial changes may precede the inflammation of the conjunctiva, but this point requires further investigation. The disease starts in the adenoid tissue, but this is soon followed by an accumulation of plasma cells, and then the hypertrophied stroma becomes sclerosed or hyaline. The epitarsal elastic fibres increase, but have very little to do with the conjunctival proliferations. In the stage of retrogression the plasma cells degenerate, while the mast cells and the hyaline degeneration increase. The milky opalescence of the surface is caused by hyaline thickening of the subepithelial connective tissue.

The pathological appearances bear some resemblance to those of rhinoscleroma, and may, or may not, be caused by micro-organisms. The influence of light may perhaps be sufficient in itself to act as a cause, as it certainly does in certain dermatoses.

Eosinophil cells are often, but not constantly, found in the conjunctival proliferations, while their increase in the blood is much rarer. On the other hand, as first pointed out by Herbert, they are surprisingly numerous in the conjunctival secretion.

Alterations in the blood are found in spring catarrh much more frequently than has been suspected up to the present. They consist not so much in an absolute increase in the white corpuscles, as in a

relative increase of the number of lymphocytes. It would be important to determine to what constitutional condition this affection is due.

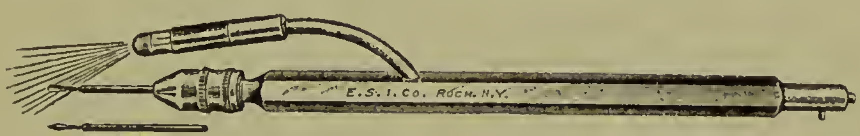
Under the influence of a bandage, or by exclusion of light by other means, the proliferations undergo a remarkable diminution in size and sometimes disappear. Nevertheless it remains doubtful whether light is really the active agent in the causation of the disease, since many cases begin, or relapse, without any definite relation to periods of insolation, and, moreover, the great irradiation of light from the Alpine snows does not generally cause relapses. Acting on the supposition that the ultra-violet rays are important factors in the development of the disease, as in æstival dermatoses, Axenfeld proposes to try the effect of covering the lids with an impermeable varnish containing quinine, or of protecting the eyes by glasses containing a solution of the drug, which destroys the ultraviolet rays by changing them into fluorescent rays. It is rare, however, for spring catarrh to be associated with skin diseases and when this occurs it is probably only a coincidence. Excision of the fibrous conjunctival growths does not usually prevent relapses, and should only be performed in severe cases and then the tarsus may be partially removed. This operation is rendered more effective by combining it with cauterization or electrolysis. Local treatment by drugs seems only to have the effect of relieving the symptoms and the author states that he knows of no cases having a duration of less than four or five years. The drugs used are numerous; amongst them are white precipitate, dilute acetic acid (to relieve itching), adrenalin, salicylic acid, ichthyol, antipyrin, etc. Massage, cold or iced applications, or warm fomentations have also been approved of. X-rays and radium have of course also been tried. Indeed the multiplicity of the remedies employed is, as usual, inversely proportional to their efficacy.

Springing mydriasis. See **Mydriasis, Spasmodic,** p. 8258, Vol. XI of this *Encyclopedia*.

Spring water. See **Water.**

Spud. An instrument employed for the removal of foreign bodies imbedded in the eyeball. An *illuminated spud.* A. C. Snell (*Ophthalmology,* April, 1908) believes that most of the difficulties encountered in the removal of any foreign substance from the *cornea* are undoubtedly those which have to do with obtaining and maintaining proper illumination at the exact point of operation. In order to focus the light brightly on the object to be removed there is commonly used a four-inch condensing lens which is held at the proper focusing distance between the source of light and the object to be illuminated. The source

of light is a fixed point while the area of illumination, the cornea, is a spherical, movable surface. When these three factors—source of light, condensing lens, and illuminated area—are in their proper relation to each other a foreign body can be clearly seen. In order to accomplish this desideratum the patient's head must be turned in the right direction so as to bring that portion of the cornea in which the foreign body lies in the direction of the line of light, the patient must fix his eyes steadily on some object (being directed to keep both eyes open), and the surgeon or an assistant must hold the condensing lens steady and at the right focal distance. If the patient fixes his eyes as directed, if he holds his head perfectly still, if the condensing lens is held at the right focus, and if the spud, hand or arm does not get into the way or obstruct the light, it would be an easy procedure to remove a foreign body. But it is rare, indeed, when all these conditions exist. It is seldom that a patient can fix his eyes on an object, or hold his head still, while the surgeon digs out a piece of steel or other foreign substance from the cornea. Any movement of the patient's eyes



Snell's Combined Eye Spud and Needle Holder.

head, or of the condensing lens, throws the foreign body out of view and renders our efforts at removal futile.

Although the removal of a foreign body from the cornea seems to be a simple matter, every one who has done much of this work has had his patience sorely tried in his attempts to get the patient to fix his eyes properly and to hold his head as it is placed while the surgeon holds the condensing lens in one hand and a spud in the other. When we use an eye speculum to aid us we find the patient is still more difficult to control, and an assistant to hold the lids open is not always at hand. Under such circumstances we all have wished for more than a single pair of hands and have found that the operation is not so simple as it at first appears.

However, with the use of the electrically-illuminated spud, most of these difficulties are eliminated. The source of light, the condensing lens and the spud are all incorporated into one instrument and thus require the use of but one hand, leaving the other free. The condensing lens-lamp is so placed that the area of focal illumination always lies in the center of the field of operation; that is, it is just in front of and surrounding the point of the spud; so that the proper relation

between these essential factors—the source of light, the condensing lens, and the object—are practically fixed and invariable. The condensing lens-lamp is placed in front of the operator's hand so that nothing can possibly get into the path or into the field of illumination, and the light is always where the operator wishes it to be, no matter where the patient turns his head.

With the use of this instrument the operator may stand in any position he chooses, either in front of his patient or behind him, to suit the surgeon's convenience. The patient may hold his head in any comfortable or natural position, and he may be placed either upright in a chair or in a reclining position on the office table as may be most convenient. A speculum is unnecessary, as the free hand may be used to hold the lids open.

Snell has found also that this instrument is useful and convenient in performing a capsulotomy after cataract extraction, many of the same annoying difficulties being removed that are encountered in the removal of a foreign body from the cornea.

He claims that the advantage of this instrument to the surgeon over the old method are:

1. The light is always exactly where the operator wishes it. 2. Nothing can get in front of the light to obstruct it. 3. The operator may choose any position. 4. Patient may rest his head in any comfortable position. 5. An assistant is unnecessary. 6. A speculum is not necessary. 7. Spuds can be removed from the handle for sterilization, or, in fact, the entire instrument may be boiled. The mechanical advantages of this instrument are: a. It is light in weight and well balanced. b. Being hexagonal, the operator can get a firm grip. c. By a chuck mechanism the spuds are securely held and can be easily removed from the handle of the instrument so that different forms of spuds or knives may be used. d. The more expensive parts of the instrument are practically indestructible and the spuds or knives can be replaced when they become unfit for further use.

For the removal of a foreign body imbedded in the cornea the narrow bladed, sharp pointed Graefe knife is often as good an instrument as can be found, but very practical models of Dix, Todd, Becker and others are also in use.

F. C. Todd's instrument (*The Ophthalmic Record,* May, 1906, p. 208) is made with a V- or U-shaped groove, beveled on the flat, at several angles. A. Schapringer (*Am. Jour. of Ophthal.,* Oct., p. 200, 1884) has invented a small scoop about 3 mm. long, attached transversely to the shaft of the instrument.

Spurge-laurel. *Daphne mezereum.* The same as spurge-olive and mezereon. In ancient Greco-Roman times, esteemed as a remedy for trichiasis, distichiasis, and corneal cicatrices. When to be employed for the corneal scars, it had to be gathered just before sunrise, while the gatherer stated clearly the purpose he had in view. When used to prevent the return of eyelashes after epilation, it was mixed with frog's blood. Mezereon seems also to have had some reputation in veterinary ophthalmology.—(T. H. S.)

Spurge-olive. See **Spurge-laurel.**

Spurious cataract. False cataract; see p. 5142, Vol. VII of this *Encyclopedia.*

Spurious neuritis. See **Neuritis, Spurious,** p. 8329, Vol. XI of this *Encyclopedia.*

Spurred rye. See **Ergot.**

Spy-glass. A small hand telescope.

Squamous. Scaly, or plate-like.

Square. An instrument for use in marking or comparing angles. That form used for determining right angles is called the normal square.

Square knot. See **Reef knot,** p. 10912, Vol. XIV of this *Encyclopedia.*

Squibb's condenser. A condenser on the principle of Liebig's, but upright and having the vapor tube doubled in the form of a V, in order to economize space in the use of the apparatus.

Squill. *Scilla maritima.* According to Dioscorides and Pliny the elder, a remedy for "weak sight." It was used in the form of a vinegar, prepared in the following manner: The roots, cut in fine pieces (none of which was allowed to come in contact with any of the others) were hung up in the shade for forty days. To one mina of these pieces was added twelve sextarii of vinegar, and the whole, in a sealed vessel, was hung up for forty days in the sun. The fluid was then poured off and used.—(T. H. S.)

Squint. Strabismus. Crossed eyes. This subject in all its bearings is considered under **Muscles, Ocular,** p. 7874, Vol. X, as well as p. 8023, Vol. XI of this *Encyclopedia.* A number of purely **Squint** rubrics are given here, but as a rule even they are best consulted under **Muscles, Ocular,** and the corresponding **Strabismus** captions.

Squint, Alternating. See p. 276, Vol. I of this *Encyclopedia.*

Squint, Concomitant. Concomitant strabismus. Comitant squint. In comitant or concomitant squint—as the adjectives imply—the non-fixing eye generally follows or accompanies all the movements or excursions of the fellow organ. In other deviations—paralytic squint for example—there is a limitation of these excursions, so that

the deflected eye does not necessarily accompany the ocular movements of the other eye. See **Muscles, Ocular.**

Squint, Comitant. See **Squint, Concomitant.**

Squint, Divergent. See **Muscles, Ocular;** also p. 4052, Vol. VI of this *Encyclopedia.*

Squinter. One affected by strabismus or squint.

Squinting angle. The angle formed by the visual axis of a squinting eye with the normal visual axis.

Squint, Lateral. The condition in which the deviating eye turns directly *in* or *out.*

Squint, Monocular. UNIOCULAR SQUINT. The form of strabismus in which one eye always squints.

Squint, Spastic. That form in which the eye deviates from the normal as the result of spasm. It is a rare condition. See **Spasm.**

Squint, Uniocular. See **Squint, Monocular.**

Squint, Vertical. The form in which the deviating eye turns directly *up* or *down.*

Squirrel-plague conjunctivitis. CONJUNCTIVITIS TULARENSIS. See p. 3157, Vol. V of this *Encyclopedia.*

Staar. (G.) Cataract.

Staarfell. (G.) The lenticular capsule when it is affected with cataract.

Stab. (G.) A rod or staff.

Stäbchen. (G.) A little rod; a bacillus.

Staffordshire knot. A knot formed by carrying a silk ligature through tissue by a needle and withdrawing the latter so as to leave a loop on the distal side; this loop is drawn over the tissue, one of the free ends of the ligature is passed through it, and both ends are made tense and secured by a reef knot; used for tying pedicles.

Stage. The platform on which the microscopic object is placed.

Stage-forceps. A clamp for supporting an object on the stage of a microscope.

Stage-micrometer. A micrometer attached to the stage of a microscope.

Stage-plate. A glass plate having a ledge adapted to support an object on the stage of a microscope when the stage is inclined.

Staggers, Blind. A form of vertigo due to cerebral disease accompanied by convulsions, blindness, etc.

Stag, The. The horn of a stag was supposed by Pliny and Dioscorides to be an excellent remedy for ocular wounds and for *scabritia oculorum.* The very tip of the antlers was believed to be the most efficacious. The horn was first washed, then pulverized, and finally placed in a vessel of clay, and roasted.—(T. H. S.)

Stahly, Georg von. A distinguished Hungarian ophthalmologist. Born at Pesth in 1755, he was made professor of surgery, obstetrics and ophthalmology in his native town in 1792. He was ophthalmologist to the King of Hungary, was ennobled in 1797, and there died Oct. 2 (or 26), 1802, aged only 47. He left no writings of an ophthalmologic nature.—(T. H. S.)

Stain. Any dye, reagent, or other material used in coloring tissues for microscopic observation. Stains used in microscopic work may be divided into basic stains, which show special affinity for the nuclei of cells, and are, therefore, known as *nuclear stains,* and acid stains, which color more readily the protoplasm—*protoplasmic stains.* Certain stains, which we may know as *selective stains* (they may be either basic or acid), color one tissue element more vividly than others, or to the exclusion of others. Since the various tissue elements show affinity for different stains, preparations may be colored with more than one stain. Accordingly, we have *simple, double, triple,* or *multiple* staining. See **Laboratory technique,** p. 6908, Vol. IX of this *Encyclopedia.*

Corneal stains. These are employed chiefly in mapping out defects in the corneal epithelium—in particular to determine the limits of corneal ulcer (q. v.) and the exact locality of foreign bodies. Dropped into the conjunctival sac they stain the defective area so that the contrasting color (green, yellow, red, blue) is readily seen. Chief among them are fluorescein (q. v.) and its compounds with sodium and potassium, but there are several others about as effective. Among the latter are uranin, escorcin, methyl violet, methylene blue, blue and yellow pyoktanin, all of which are described elsewhere in this *Encyclopedia.*

Stains, Corneal. See **Stain,** supra.

Staircase experiment. See **Schroeder's staircase.**

Stamps for ophthalmic records. See p. 4567, Vol. VI of this *Encyclopedia.*

Stamps, Oculists'. See **History of ophthalmology,** p. 8571, Vol. XI of this *Encyclopedia.*

Stanculeanu, George. A celebrated Rumanian ophthalmologist, renowned especially for his researches in the anatomy and comparative anatomy of the eye. Born in Rumania, June, 1874, he received the medical degree at Paris. In 1908 he was appointed professor of ophthalmology in the University of Bucharest, Rumania, succeeding in this position his father-in-law, Manolesco. Early in the War, he removed to Jassy, France, where, for a time, he practised ophthalmology. In 1917, after our entry into the war against Germany, he

came to America with Madame Stanculeanu for the purpose of arousing sympathy for Rumania. Soon after his arrival he became ill, but nevertheless set out on his lecturing tour and worked till work was for him no longer possible. He died at a sanitorium in Stamford, Conn., July 15, 1917, of pneumonia, survived by his widow but no children.

Dr. Stanculeanu was a short, well built man, five feet five inches high, of a quick, brisk, very friendly manner. His hobbies were

George Stanculeanu.

photography and the collection of rare books. He was a member of the Greek Catholic Church.—T. H. S.

Stand, Treatment. See under **Hospital**; and **Treatment stand.**

Standard acuteness of vision. The power of the eye to distinguish letters and characters occupying an angle of five minutes.

Standard symbols for lenses. See **Symbols, Standard**, to designate the optical properties of lenses.

Stanhope lens. A simple microscope, consisting of a thick double convex lens of unequal curvatures.

Stanhoscope. A plano-convex modification of the Stanhope lens.

Stanley, John. A celebrated blind musician. He was born in London in 1713, and, at the age of two, was blinded by an accident. At the age of 7 he began to study music under a Mr. Reading, who was organist of Hackney church. Later, he spent a year or two with a

Dr. Green. When only 11 years of age he was made organist of All Hallows, Bread St. He was also conductor of the concerts at the Swan and Castle, City. In 1759, he succeeded Handel as conductor in the performance of the oratorios at Covent Garden Theatre. It is said that, at a performance of Handel's "Te Deum," Stanley, finding his organ a half tone higher than the other instruments, at once and without the slightest hesitation transposed the whole composition from the key of D to seven sharps major. For years he was Master of the King's Band.

His own chief compositions were: "Arcadia, or the Shepherd's Wedding," a dramatic pastoral, and the oratorios of "Jephtha" and "Zimri."

He died May 16, 1786, aged 73.—(T. H. S.)

Stannotype. A tintype photograph.

Staphylectomy. Ablation, Excision or Abscission of staphyloma. See, also, **Staphylotomy** (with which this term is often confounded) as well as p. 37, Vol. I; p. 3471, Vol. V, and p. 4419, Vol. VI of this *Encyclopedia.*

Peter A. Callan (Wood's *System of Ophthalm. Operations,* Vol. II, p. 980) notes that Ambrose Paré excised the entire mass and allowed the parts to heal. Boerhaave (*Prælectiones publicæ de Morbis Oculorum,* 1748, pp. 58-60) resorted to the use of ablation in the surgical treatment of excrescentia corneæ. Beer (*Ansicht der staphylomatösen Metamorphosen des Auges und der künstlichen Pupillenbildung.* 1805) performed abscission. He made the puncture and the counter puncture in the horizontal meridian of the mass at the base of the elongated cornea with his well-known triangular cataract knife. He directed the edge of the blade of the instrument forwards and downwards, cutting the base of the mass from outwards within. This done, he made a similar incision upwards with a pair of scissors, thus completing the abscission. The lens and a portion of the vitreous humor frequently escaped through the opening. It is believed by some that the procedure is peculiarly valuable in the treatment of old, thick-walled staphylomata.

In conformance with Celsus' proposition (*De Medicina,* lib. VII., Cap. 7) to excise an elliptical-shaped area of the size of a lentil seed from the apex of the staphyloma, allowing the crystalline lens and the vitreous humor to remain, and then to have closure of the opening take place, Scarpa (*A Treatise on the Principal Diseases of the Eye: English Translation by James Briggs,* 1818, p. 407) excised a small lenticular-shaped piece of "two, three, or four lines in diameter" from the staphylomatous summit, through which he states he forced

the crystalline lens and vitreous humor; (entirely too small an opening, as Ware says, to permit such a procedure "without forcibly compressing the iris"). Richeraud and Langenbeck (*Traité theorique et pratique des Maladies des Yeux,* 1847, p. 339) advised similar procedures.

"Staphylotomy" (he should have stated "staphylectomy" as he describes this latter operation in his communication), is said by Abadie (Congrès international periodique d'Ophtalmologie, Copenhagen, 1884) to be of exceptional value for the removal of large isolated staphylomata which have adjacent clear corneæ, and are complicated by anterior synechia in shallow anterior chambers.

The clear cornea just beyond the staphylomatous area is punctured with a von Graefe knife. The incision is made so as to include the iris tissue. The handle of the knife is then depressed, and the point of the instrument is carried forward until the opposite side of the staphyloma is reached, when it is pushed through the iris and the cornea. The included iris and cornea are excised. The procedure frees the cornea from the constant drag of the synechia, the staphyloma flattens, and the scar heals with a consequent fairly good curvature.

In total staphyloma, Middlemore (*A Treatise on the Diseases of the Eye and Its Appendages,* 1835, Vol. 1, p. 521) operates by transfixing the center of the cornea with a pair of hooked forceps, and passing a triangular cataract knife through the whole protrusion (which in this case involves the entire cornea) midway between its center and its margin on each side, and urging it forward until it "cuts its way out" at the opposite side. The upper or lower flap is then excised with a pair of curved scissors "observing as nearly as possible the same directions with regard to the magnitude of the part excised, and the distance of the incision from the border of the cornea, as regulated (the) operations in making the lower incision." The lens, which is generally diminished in size, with a small portion of the vitreous, will be discharged. Should the lenticular capsule and its retained lens remain in their proper positions, he advises us to leave them *in situ,* so as to permit the eyeball to retain a better appearance. Should any hemorrhage occur, he waits a brief period of time before applying a bandage. Cold compresses are employed and rest in bed—particularly in cases in which there is much reaction—which is quite apt to occur—is strictly enjoined. He advises excision of the summit of partial staphylomata.

Tyrrell (*A Practical Work on Diseases of the Eye,* 1840, Vol I, p. 271) after speaking of the employment of local medication and attention to the general health in the treatment of the condition, tells

us that for "complete staphyloma, nothing further can be done except by operation." The method which he describes is extremely simple —"A needle armed with a ligature or a curved cataract needle, should be passed through the staphyloma, to enable the surgeon to fix the globe, whilst he passes a pointed knife through the base of the projection, and separates it from the globe. The removal is usually followed by the escape of the lens, and a large part of the vitreous humor:" the remaining tunics, in a degree, collapse.

In performing the operation, a sufficient opening should be made to allow of the escape of the humors; otherwise, a fresh staphyloma is likely to form. In addition, he gives the sage advice "I should not advise the operator to interfere with the sclerotic tunic, as I have observed that severe suppurative inflammation has followed, in several cases in which that coat has been divided."

Frick (*A Treatise on the Diseases of the Eye,* 1823, p. 92) says that in the more inveterate species of the disease, or in the *staphyloma totale,* he prefers simple and total excision without sutures. The lens and the vitreous are, if possible, left undisturbed. "The dressing and after-treatment are the same as in the operation for cataract." In regard to the treatment of partial staphyloma he tells us "that when the disease is connected with a varicose state of the vessels (cirsòphthalmia), it becomes a perfect *noli me tangere,* and any attempt to remove the deformity or blindness, is attended with an aggravation of all the symptoms."

Wilde (*The Dublin Quarterly Journal of Medical Science,* 1847, Vol. III., p. 242) introduced a curved needle through the staphylomatous base. He then removed the mass with a cataract knife and scissors, drawing the needle through and tying the ligature.

In regard to the practice of Woolhouse (See also de Saint-Yves' operation for total staphyloma when an artificial eye is to be applied, on p. 309 of Stockton's English Translation of "*A New Treatise on the Diseases of the Eye,*" 1741) including the sclerotic coat in the circular division of the mass, it has been justly said that "such a mode of treatment is invariably followed by violent inflammation of the eyeball and eyelids, most acute pain in the head, watchfulness, convulsions, copious suppuration, and sometimes gangrene of the eye and eyelids."

Knapp (*Archiv für Ophthalmologie,* 1868, Vol. XIV., I., p. 273) arranged two suture threads so placed as to make them act vertically. Properly, he avoids passing them through the ciliary region.

In 1873, de Wecker (*Annales d'Oculistique,* XIX., p. 51, and de Wecker and Landolt, *Traité complet d' Ophtalmologie,* 1886, Volume

II., p. 208) incised the entire conjunctival limbus, dissected it backwards, and placed four differently tinted sutures in the conjunctival border. He excised the staphylomatous area, and after liberating and expelling the crystalline lens, brought the wound together. In 1882, as Beard says, "he wisely concluded to make complete exenteration of the globe before closing the wound."

Borghetti has made use of the first and second steps in the modified de Wecker operation. He detaches the conjunctiva from the sclera for about the width of one centimeter around the corneal limbus. He places a circumferential purse-string suture in the detached portion of the conjunctiva. A second purse-string suture is passed into the superficial layers of the sclera and episcleral tissue; this suture is bound except at the lower part of the eyeball where the two ends are made to pierce the conjunctival membrane. By pulling upon the two ends of the thread, the eye is fixed and closed, while a flap which is equal in size to four-fifths of the tissue to be removed, is made by means of a cataract knife. The loosened flap, which is still adherent to the lower part of the eyeball, is now ready to be excised. The conjunctiva is brought in front of the eyeball. Lastly, the suture holding the sclerotic is loosened to prevent the ciliary nerves from suffering compression, and the two ends of the thread are knotted.

He claims that with this method of procedure, "The ciliary nerves suffer no pressure and there is no fear of sympathetic ophthalmia:" "The method can be applied where other methods cannot, and even when chloroform is contra-indicated, or when intelligent assistance is not easily found," and, "An artificial eye can be placed on the stump which moves freely in all directions."

In cases of adherent leucoma with thinning of the cornea and the formation of staphyloma, Sachs (*Zeitschrift für Augenheilkunde,* January, 1902, p. 37) suggests the trephining of the central part of the cornea with von Hippel's trephine, release of the iris, and replacement of the disc. He believes that the success of the procedure is due to a permanent lowering of intraocular pressure, as a consequence of the release of synechia, and to a flattening of the cornea which results from the scar tissue.

The *modern* operation of staphylectomy is done in the following way: After the usual preparation of asepsis and fixation, the staphylomatous mass is separated from its base for about two-thirds of its extent. This is best done by a Beer knife.

The second step in the procedure, consists in removal of the remaining portion, or better, whenever possible, to conform it into a flap to cover the opening and "to serve in the formation of a flat cicatrix."

The best-known operation for removal of the cicatricial total type of staphyloma is that of George Critchett (*Royal London Ophthalmic Hospital Reports,* Vol. IV., 1863, part I., page 1). It consists in the removal of an elliptical portion of the cicatrix and coapting the edges of the wound by stitches. It is only suitable in cases of total cicatricial staphylomata, especially in those "with thick walls or even button-like thickened zenith, where a restitution of vision is impossible, and it is only a question of forming a stump for an artificial eye."

General anesthesia is necessary. After the parts have been prepared, and the eyelids separated by a stop speculum, four or five needles, armed with surgeons' silk, are passed through the staphylomatous area, and, at times, the sclera in the ciliary region, in the same manner. This having been accomplished, an elliptical area, made in the points of entrance and exit of the needles, is excised by means of a Beer knife and a pair of scissors. The elliptical flap in the staphyloma removed, the free edges are brought together and tied with the silk sutures, which are allowed to remain *in situ* until the parts are well united; the period of time averaging about a fortnight. The author of the operation states that the crystalline lens must be removed at the time of the procedure.—(P. A. C.)

W. Boer (Graefe's *Archiv f. Ophthalm.,* 81 I., Feb., 1912) reports a case of large cyst which appeared two years after Critchett's operation for staphyloma. The cyst consisted of two concentric fibrous layers with an internal and external epithelial lining. Boer discusses the origin of these cases, two of which have been reported, and while denying their connection with accidental implantation of epithelium during the operation (Uhthoff), considers that they are due to a conjunctival fold which becomes drawn in between the points of the suture, sealed up, and gradually distended. Thus both the internal and external epithelial layers are analogous to conjunctival epithelium.

Staphylococcus. The varieties of this organism that infect the eye are described and their detection and activities discussed on p. 782 *et seq.,* Vol. II of this *Encyclopedia.* In addition the reader is referred to p. 3163, and p. 3501, Vol. V.

Discussing the subject, Mayou (*The Ophthalmoscope,* Aug., 1908) has reported fourteen cases of staphylococcal infection of the eyes. Eight were extraocular, and were mostly associated with acne rosacea, styes or boils. The ocular affections were *corneal ulcers, phlyctenulæ, conjunctivitis and blepharitis.* The intraocular affections were metastatic and post-operative infections. The vaccine used

was the mixed staphylococcal vaccine prepared by the Jenner Institute of Preventive Medicine, or a vaccine prepared from the patient's local lesion, after the method of Wright. The opsonic index was watched in most of the cases, but is not deemed absolutely essential. The first dose should not exceed 500 million staphylococci, but may be increased to 2,000 million. In the multiple lesions of the face and eyes, the ocular lesions got well much faster than the face lesions; although the face lesions improved in all cases, some did not get well completely or were only slightly improved. Of the intraocular affections, two cases of metastatic panophthalmitis are reported in which enucleation was performed. In both cases the staphylococcus albus was found in smear preparations of the pus from the eye and in pure culture on the media. Three cases of metastatic iridocyclitis were reported, in one of which some aqueous was collected, and from this a pure culture was obtained of staphylococcus albus. Complete and rapid recovery took place in these three cases upon vaccine treatment. He speaks of three cases of suppuration following needlings in all of which the staphylococcus albus was found in pure culture.

Johnston (*Prac. Med. Series,* Eye, p. 25, 1908) gives the history of a child, 9 months old, at the termination of an attack of measles, who developed an inflammation of the conjunctiva of the left eye, with swelling of the upper lid and profuse lachrymation. On opening the lid Johnston found a discharge of sero-purulent fluid, and on everting the lids the palpebral conjunctiva was found covered with a pseudo-membrane of a whitish color. This membrane did not continue beyond the fornix and was readily stripped from the part with forceps. Cultures showed the presence of the *staphylococcus aureus* and *albus*. No other organism was found. The child was lost sight of before the eye recovered. See, also, **Scleritis, Metastatic.**

Staphylococcus aureus. McIlroy (*Br. Med. Journ.,* p. 405, Apr. 5, 1919) found the chief micro-organism obtained by agar culture from nine cases of purulent discharge from the eye socket to be the *staphylococcus aureus.* Methylene blue, although proved to be very active clinically in cases such as this one, was found to have comparatively little bactericidal action on the staphylococcus obtained from the discharge; 0.03 c.c. of a very dilute emulsion of the micro-organism, after even twenty-four hours' exposure to the drug, still yielded a number of colonies of growth after incubation. See, also, **Staphylococcus.**

Staphyloma. STAPHYLOMA OF THE CORNEA. KERECTASIA. PROLAPSUS CORNEÆ. CONIC CORNEA. PROJECTING STAPHYLOMA. A more or less irregular protrusion of some one of the tunics of the eye, due to a

thinning or to a perforation from previous ulceration or other disease. See p. 3467, and p. 3504, Vol. V of this *Encyclopedia.*

Congenital anterior staphyloma. The following case has been reported by E. Treacher Collins (*Oph. Review,* p. 119, April, 1909.) A child, aged one month, was brought for treatment on August 14th, 1907, with the right eye unduly prominent, a condition which had been noticed immediately after birth. There was nothing in the history of the confinement likely to account for the appearance.

The right cornea was found to be opaque, vascular, and staphylomatous, the greatest density being in the central region; the lids were incapable of closing over the projection. The iris appeared to be in contact with the back of the cornea throughout. There was also a slight haziness in the left cornea. During the next 14 months the prominence of the right cornea increased, and on October 14th, 1908, it was decided to eviscerate the eye, the anterior part, containing the cornea, part of the ciliary body, and lens, being preserved for examination purposes. The macroscopical appearance bore out what was seen clinically; the lens was clear, except at the anterior pole, where a conical projection was visible.

By microscopical examination the following points could be observed: the epithelium was thickened and in places horny; there was irregularity of the layers of fibrous tissue composing the cornea, with some increase in the cellular elements; absence of Bowman's membrane, Descemet's membrane, endothelium, and the ligamentum pectinatum; posterior surface of the cornea lined by a double layer of pigment epithelium, with a gap corresponding to the pupil, eccentrically placed; between this layer and the posterior surface of the cornea scattered collections of spindle-shaped cells representing the remains of iris tissue; evidences of dislocation forward of the uvea, commonly met with in congenital staphyloma.

Collins referred to the cases of Parsons (*Trans. of Oph. Soc.,* vol. xxiv, p. 47) and Coats (*Trans. of Oph. Soc.,* vol. xxvi, p. 36), as well as to a paper in *The Ophthalmoscope,* vol. iv, p. 214, by Sydney Stephenson and Rosa Ford. He sought to show that the views generally expressed regarding prenatal ulceration and perforation were not borne out by the microscopical findings nor were they consistent with the length of time usually necessary for formation of a staphyloma in ordinary postnatal inflammatory perforation. Collins held that the abnormality was due to failure of development, a view which was supported by the frequent presence of associated deformities in other parts, as well as the occasional appearance of a mass of dermoid tissue in front of the staphyloma, to which the thickened, horny epith-

elium noticed in the present case was somewhat allied. He held that the absence of Descemet's membrane was decidedly against an inflammatory theory, since in postnatal perforation some parts of it were invariably preserved. He thought that the entire phenomenon could be explained by atypical development of the mesoblastic tissue which insinuates itself between the lens and the surface epiblast; this fails to become differentiated into its three parts, viz.: an anterior non-vascular layer, a hyaline membrane, and a posterior vascular layer.

Treatment of staphyloma. This matter is discussed as follows in Wood's *System of Ophthalmic Operations,* Vol. II, p. 972. When the imperfectly termed condition of *staphyloma corneæ* is partial and but slight, it is to be met surgically as nearly as possible. *Compression, ligation, cauterization, incision with pressure, and excision* are among the best-known radical measures that have been adopted for its removal. If the partial type be fresh and larger, iridectomy, either opposite the most transparent portion of the cornea or so situated, in favorable cases, in positions to get rid of disturbing anterior synechia, in connection with abscission, and cauterization, are better adapted to meet the requirements in each particular case. In the coarsest and grossest partial types, the protuberant mass must be opened, freed of its contents, and thoroughly cleaned to the floor of the sac; any fistulous communications with the eyeball proper being carefully cauterized.

Enucleation is the only remedy when intraocular tension has become permanently or even intermittingly increased in spite of the performance of the minor procedures, such as incision, excision, or avulsion of the iris *(iridavulsion)*, as practised by Noyes. (*A Text-Book on Diseases of the Eye,* 1894, p. 417.)

Beer stated (*Lehre von den Augenkrankheiten,* 1817, II, S. 216) that he had successfully removed more than two hundred staphylomata by operation, without any dangerous complication.

Compression treatment of beginning staphylomata from both traumatism and penetrating chronic inflammation of the cornea, is quite old. The compresses, which were graded, are said by both Wenzel and Ware to be inconvenient and useless.

Among the best known of the simplest radical procedures is that employed by Woolhouse for the reduction of herniaed irises following cataract extraction. He termed the method emboitement. He used a metallic instrument so constructed as to fit over the eye. After oiling its convex and concave sides, he introduced it under the eyelids in such a manner that it might press the tumor on the cornea.

Similar contrivances have been uselessly and even dangerously employed since.

Treatment of staphyloma corneæ by ligation and seton. The operations by litigation and seton are very old ones, dating back to the times of the ancient authors Celsus, Paulus Ægineta and others, who advised the carriage of a double-threaded needle through the base of the mass. Each suture was tied to the side of the projection, thus leaving an intervening ligatured area to slough away and cicatrize. Ætius made use of two needles placed at right angles to one another. For the removal of partial staphylomata, de Saint Yves (*A New Treatise of the Diseases of the Eyes,* English Translation, 1741, p. 205) lucidly and quaintly tells us "I take an edged needle, somewhat crooked, threaded with Silk. I pass it through the middle of the staphiloma; when the silk is run through, I withdraw the needle, and holding both ends of the silk with my left hand, twist them a little; afterwards with a lancet, I cut the tumor in its basis below the silk, and with one nip of my scissors, I take it off entirely."

In 1841, Furnari (*Traité Pratique des Maladies des Yeux,* 1841, p. 309) stated that use of the seton recommended by the ancients, was generally abandoned in his day by reason of the accidents which it produced. Roux employed it in 1827.

Borelli (*Compte rendu du Congrès d'Ophtalmologie de Bruxelles.* 1857, p. 438) made use of two pins inserted at right angles with one another. Beneath them he passed a strong piece of silk so as to forcibly compress them together, thus strangulating the mass. A compress bandage placed over English taffeta was applied. He reports that cure took place very quickly and that it lasted for many years.

Middlemore (*A Treatise on the Diseases of the Eye and Its Appendages,* 1835, Vol. I, p. 520) could not recommend the double ligature for the cure of staphyloma "for it is painful, tedious, and, in some instances, as regards its effects, an ineffectual mode of procedure."

In a clinical observation of a case of secondary staphyloma of the cornea from ulceration, Fieuzal (*Fragments d'Ophtalmologie. Clinique de l'Hospice des Quinze-Vingts,* 1880, II., p. 368) cites the good results from an operative procedure which arose from ocular drainage with cessation of pressure symptoms and rapid decrease of inflammatory reaction, secured by the aid of the insertion of a seton in the form of a thin gold thread.

Cauterization of corneal staphyloma. In more recent years, Richter (*Observationes Chirurgicae,* Fasciculus II) produces "an artificial ulcer upon the base of the tumor of the cornea, by means of the reiterated application of the argentum nitratum or the antimonium

muriatum,'' and keeps it open by the repeated use of these caustics. He mentions a ''cure'' by this method in fourteen days' time. Scarpa says that he is ''sorry to be obliged to declare that although he had frequently adopted this method of treatment in the recent staphyloma of infants,'' he had ''never had the gratification to obtain such success, either with regard to restoring the transparency of the cornea or diminishing the size of the staphyloma, as to be in any degree compared with that obtained and recorded by Richter.'' As to its use in the inveterate staphyloma of adults, he doubts whether it will be ever easy to ''produce a persuasion that the same mode of treatment can ever be of utility in obtaining a diminution of the size'' of such protrusions. Middlemore does not believe that the application of caustic is suited to very young subjects ''on account of the extreme thickness of the cornea in very early life, and the consequent difficulty of destroying the whole of the corneal lamallæ, so as to penetrate the anterior chamber.''

As at present done, the parts operated on are to be carefully cleansed, the eye is to be lightly covered with an evenly placed and firm pressure bandage, and the patient placed in bed. Care should be taken during cauterization to limit the main burning to those portions that should be strengthened for later cicatrization.

For the *incision* and *excision* operations, see, also, **Staphylectomy** and **Staphylotomy.**

Proeller (*Archiv für Ophthalmologie*, LVI., 2, S. 315) makes use of *transplantation of the cornea* simply to avoid enucleation or its substitutes in functionless eyes that are affected with total staphylomata of the cornea—particularly in those cases which have followed severe ulceration.

Iridectomy in staphyloma corneæ. Sperino (*Etudes Cliniques sur l'Evacuation Repétés de l'Humeur Aqueuse dans les Maladies de l'Oeil,* French translation by Raymond, 1862) reports some very interesting and instructive cases of the disease in which the value of *iridectomy* alone or in association with repeated evacuation of the aqueous humor, is compared and contrasted; the combination of the two methods apparently giving the better results. Von Graefe (*Archiv für Ophthalmologie*, IV., II., S. 271) realizing the important fact that excision of a portion of the iris diminishes intraocular pressure, applied it to the treatment not only of conical cornea, but usefully to some staphylomatous conditions. It is also of value, he says, in favorably changing the position of the pupil in such cases. It is probably of the most use in the progressive types of the disease.

In 1829, Flarer (*Manuel Practique d'Ophthalmologie ou Traité des*

Maladies des Yeux, 1834, p. 272) resorted to the establishment of an artificial pupil after repeated punctures with a cataract knife had been employed.

Himly (*Krankheiten des Auges,* 1843, S. 69) also made use of iridectomy in the operative treatment of partial staphyloma of the cornea.

As all of the procedures for the total form of protrusion are not intended for restoration of sight, but are done simply to get rid of discomfort, and, not infrequently, pain, which are the usual accompaniments of the condition, and to improve appearance and to offer better prothesis, they are here mentioned more for historic reasons than for practical ones to follow.

The coarse radical procedures that were so rife during the nineteenth and earlier centuries were mostly employed for the removal of the complete or total form. None of them, however, can be recommended, as both empiricism and scientific study have showed that they not infrequently give rise to conditions which are of much more likely to produce binocular blindness, than if the parts had been left alone. With Berry in his assertion that "the most suitable operation for cases of complete staphyloma is evisceration of the globe," the writer is in accord.—(H. B. C.)

F. Dimmer (*Centralbl. f. prak. Augenheilk.,* Aug., 1913) describes an operation for flattening partial corneal staphyloma. The epithelium is first of all removed by means of a sharp spoon from that half of the staphyloma which lies nearest the limbus. Then a small flap is made, by means of a Graefe knife, in the corneal scar. This flap is slightly curved, with its convexity towards the limbus. Then, with very small and very curved needles and the finest silk, one or two sutures, according to the size of the scar, are put in place. Each suture has two needles. One needle is pushed through the peripheral edge of the wound from behind, forwards, and the second needle passed similarly, 2 mm. or 3 mm. distant from the first. Then both needles are pushed through the flap, also from behind, forwards. As the sutures are tied, the central edge of the wound will glide over the peripheral edge, and in this region the scar will be doubled. The two surfaces will become adherent, and the uneveness will become gradually smooth. The sutures can be removed on the sixth or seventh day.

The cases most suitable for this operation are those with scars which are not too thick, but at the same time thick enough to hold the sutures.

Any operation of this kind must be preceded by measures which will permanently relieve any increase of intraocular tension, and for

this purpose a combination of an iridectomy, immediately after a cyclodialysis, is recommended. See, also, **Staphylectomy.**

C. H. Reinhold (*Indian Med. Gazette,* May, 1914) reports having operated on 17 cases of corneal staphyloma by establishing a *filtering cicatrix with the trephine.* In only four of his cases did he fail to obtain some improvement, and in six cases there was considerable improvement in vision.

He states that the operation is contraindicated in those cases where it is suspected that the suspensory ligament has given way, and the lens has ridden forward into the anterior chamber, for here there is not only liability to rupture of the lens capsule by the trephine, as happened in one of his cases, but even if the operation is successfully accomplished, the lens is apt to block the trephine hole, stopping filtration and so causing recurrence, as happened in two of his cases.

Capt. Reinhold aims at making his trephine hole almost entirely in the cornea and uses a 3 mm. trephine for very large staphylomata. He always does an iridectomy through the trephine hole, although he has found no tendency for the iris to prolapse, as in glaucoma cases.

Sameh Bey (*Clinique Ophtalm.,* p. 637, Vol. XVII, Dec., 1911) records an experience of 1,080 cases of *staphylotomy,* (q. v.). Owing to the nature of the eye diseases prevalent in Egypt, staphyloma is of frequent occurrence, and Sameh says that most of the methods described in the textbooks for performing staphylotomy are very unsatisfactory. He advises the following procedures:

1. *Partial staphyloma.* When the staphyloma is restricted to a corneal ectasia, which is generally opaque, he first practices arrachement (avulcion) of the iris with the strong forceps devised by him for this purpose. This is generally sufficient to arrest the development of the staphyloma and to make the cornea reassume its normal shape. In some cases, especially in peripheral staphyloma, where this arrachement is not sufficient, he adds transfixion of the staphyloma in its longest diameter with a slender cataract knife.

2. In *partial staphyloma with iridic adherence* or small projecting leucoma, he opens the anterior chamber with a lance, and cuts the synechiæ with his synechitome, which is really a short de Wecker spatula, sharp on both sides. The arrachement of the iris, which this procedure has made easy, is then performed.

3. In *staphylomata of medium size* with strongly adherent iris, he begins with a transverse incision of the staphyloma to within three millimeters of its edges; the synechitome is then introduced and the iris detached. The separate parts of the iris are then drawn out; this is easily done if the iris is seized at its ciliary attachment and steadily

withdrawn. The operation is concluded by extracting the lens, even though it be transparent. The capsule is opened with the point of the knife, and gentle pressure on the cornea with a curette gives birth to the lens. No corneal suture is used.

4. *Pediculated staphyloma* is cut off at its base with a convex bistoury. With a suitable bandage, healing with a flat scar is obtained.

5. *Total corneal staphyloma, conical or spherical.* He begins by excising an elliptical piece from the cornea. Arrachement of the iris and extraction of the lens, which is frequently cataractous, is practised, and the operation is concluded by placing a corneal suture, or at the most two; the sutures are lightly placed and removed on the third or fourth day. Escape of liquid vitreous is of no consequence. In ten to fifteen days the eye has assumed a fairly spherical shape, and no prothesis is necessary.

6. In the enormous distensions of cornea and sclera exenteration is practised, and care taken to secure a good stump for a prothesis. See, also, **Staphylotomy** and **Staphylectomy.**

Staphyloma, Annular. (1) A staphyloma surrounded by an atrophic choroid coat. (2) Staphyloma of the sclera in the ciliary region, extending around the margin of the cornea.

Staphyloma, Anterior. In this condition the ectasia generally affects the limbus corneæ and is a protuberant scar caused by a prolapse of the iris from a wound or perforating ulcer. It may be partial or total.

Staphyloma, Congenital. See **Staphyloma.**

Staphyloma corneæ racemosum. A variety of corneal staphyloma in which there are a number of perforations from which small portions of iris protrude.

Staphyloma, Corneal. See **Staphyloma.**

Staphyloma, Equatorial. Scleral staphyloma occurring in the equatorial region of the eye.

Staphyloma, Fistulous. See **Fistulous staphyloma,** p. 5211, Vol. VII of this *Encyclopedia.*

Staphyloma intercalare. Intercalary staphyloma. A form of the disease in which the projecting part of the eyeball lies between the insertion of the iris and the ciliary body, owing to a thinning of the ligamentum pectinatum and the region of Schlemm's canal.

Genet (*Revue Gén. d'Ophtalm.,* 30 Nov., 1913) aided excision of a ciliary staphyloma in a case where preservation of a sightless eye seemed desirable. Although the staphyloma was the result of an accident, there had never been any reaction. Trusting to the asepticity of the operation performed, Genet considers that he ran no great

risk. The operation consisted in seizing the staphyloma with special forceps, introducing ligatures beneath the grip of the forceps, tying off the staphyloma from the interior of the eye, and then excising everything behind the forceps and in front of the ligatures. The ligatures were passed in such a way that the cornea, on the one hand. and the coats of the eye behind the ciliary body, on the other hand, received the pull of the stitches. The eye remained perfectly quiet after the operation. There was no loss of vitreous.

Staphyloma of the cornea. See **Staphyloma.**

Staphyloma of the sclera. Ectasia of the sclera. Protrusions of the sclera are classified as *anterior*, *posterior*, and *equatorial*. Anterior scleral and equatorial staphylomata appear as bluish-black or grayish projections. Their color is due to the thinned sclera permitting the dark choroid to appear. In anterior ectasiæ the limbus of the cornea forms the anterior border of the projection; in some cases both cornea and sclera participate in the bulging. Anatomic examination of enucleated eyes shows two forms of anterior scleral ectasiæ, the ciliary and the intercalary. The former presents a bulging of that part of the sclera which is lined by the ciliary body, while the latter is a protrusion between the ciliary body and the corneal margin.

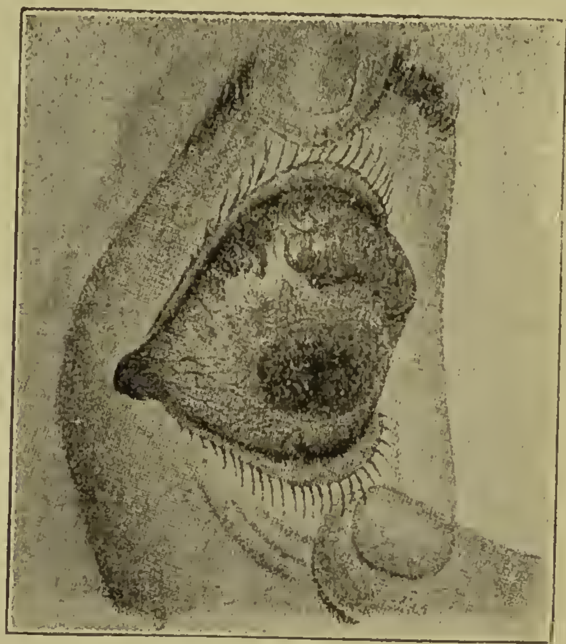
Equatorial ectasiæ can be seen only when the eye is turned strongly to the side opposite the projection. Ectasiæ occur at one or more places, where the venæ vorticosæ pass from the globe, but are said not to form a ring such as sometimes occurs in anterior staphyloma. They are the result of chronic choroidoscleritis. On microscopic examination the choroid and sclera are found atrophic and adherent.

Posterior ectasiæ involve the posterior segment of the globe. They cannot be seen except the eye be removed or the ophthalmoscope be used. These posterior projections are divided into (1) the posterior staphyloma of Scarpa and (2) the posterior staphyloma of von Ammon. The former is a protrusion situated at the temporal side of the optic-nerve entrance. If large, it involves the nerve itself. Arlt discovered that this form of ectasia is frequently the cause of myopia (axial myopia). The antero-posterior diameter of the globe is elongated, and the fundus shows a white crescentic patch embracing the temporal side of the disc. The posterior scleral protrusion of von Ammon lies below the posterior pole, and is a congenital condition which arises from incomplete closure of the fetal eye-cleft. At the present day it is best known by the name *inferior conus*. Often in such cases there is an accompanying coloboma of the choroid and iris. The conditions described above are partial ectasiæ.

Total ectasia of the sclera. While in the adult the sclera is rigid

and gives way only in certain weak places, in the young subject the eyeball can be enlarged in every direction. Such an ectasia of the sclera is often accompanied by an enlargement of the whole cornea

Equatorial ectasiæ of the sclera. (After von Ammon.)



Cirsoid ciliary staphyloma. (Vossius.)

Posterior staphyloma of Scarpa.

Ciliary staphyloma. (Pagenstecher and Genth.)

Various Forms of Scleral Staphylomata. (Ball.)

(megalocornea) or by a corneal staphyloma. In this connection the reader should refer to congenital anomalies of the cornea.

The causes of scleral ectasia include those factors which either diminish the resistance of this coat or increase intra-ocular pressure. Thus, glaucoma and exclusion of the pupil by iritis belong to the latter class, while diminished resistance of the sclera follows scleritis,

tumors, gummata, tubercular nodules, injuries, and the congenital condition mentioned above.

The results of scleral ectasia are loss of vision from increase of tension, great disfigurement in the anterior and equatorial forms, and constant irritation from exposure of the protruding mass after it reaches such dimensions that the lids cannot cover it. The posterior protrusion in staphyloma often leads to great increase in the near-sight without producing increased tension. Vision is often much reduced in these cases. The ectasia of von Ammon remains stationary, and, since it is situated below the macular region, it does not impair vision.

Treatment. Anterior and equatorial ectasiæ of the sclera should be treated by iridectomy, for the purpose of reducing tension. If this is accomplished, the process stops. If iridectomy cannot be performed, the eye is to be left to its fate, and ultimately an enucleation will often become necessary.—(J. M. B.)

A. R. Stillwell (*Am. Journ. of Ophthalm.*, Feb., 1919) reports an instance of *traumatic staphyloma of the sclera.* A coal-miner, aged 23 years, had fallen forward on his face, striking the right eye against the hard rubber handle of an electric machine. When seen two days later, there was hemorrhage in the anterior chamber, with crescentic bulging of the sclera above in the ciliary region. The cornea was intact, and the upper part of the iris had disappeared beneath the bulging sclera, the appearance being practically that of an iridectomy except that there were no angles to the pupil. The conjunctiva was not ruptured but was chemotic. The eyeball was soft and vision equal to light perception.

In a few days the fundus could be seen through the lens, which was not dislocated. The bulging of the sclera then measured 4 by 8 mm., with about 2 or 3 mm. of elevation. The bulging was dark-blue in color, probably due to thinning of the sclera with the ciliary body and anterior portion of the choroid lying beneath. Vision with —2.00 sphere was 4/12. A moderate return of pain and redness of the eyeball, a few days previously, with slight tenderness to pressure, had been readily controlled by atropin and dionin.

Staphyloma pellucidum. Conical cornea.

Staphyloma pellucidum conicum. See **Conical cornea.**

Staphyloma, Posterior. See **Staphyloma of the sclera.**

Staphyloma posticum. Posterior staphyloma.

Staphyloma, Projecting. Staphyloma of the cornea.

Staphyloma racemosum corneæ. Staphyloma of the cornea, with perforation at several points, through which small portions of the iris protrude.

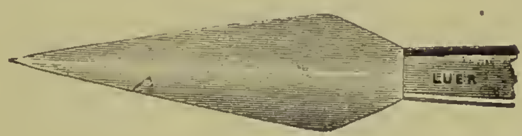
Staphyloma, Scarpa's. Posterior staphyloma. See **Conus**, p. 3286, Vol. V of this *Encyclopedia*.

Staphyloma, Total. See **Staphyloma.**

Staphyloma, Uveal. Protrusion of the uvea through a ruptured sclera.

Staphyloma verum in myopia. In high degrees of myopia a crescent-shaped shadow, with its concavity towards the optic papilla may occasionally be seen marking the border of the posterior staphyloma which in this instance in particular is known as *staphyloma verum.*

Staphylotome, Desmarres'. This instrument is a sharp, two-edged, spear shaped knife (as shown in the illustration) for use in cutting operations on staphylomata.



Desmarres' Staphylotome.

Staphylotomy. See p. 37, Vol. I, p. 3471, Vol. V and p. 4418, Vol. VI of this *Encyclopedia.* Consult, also, **Staphyloma** and **Staphylectomy**, with which latter term *staphylotomy* is frequently confused. As a matter of fact the latter word implies only an *incision* or *surgical opening* of a staphyloma; the former an *ablation, excision* or *abscission* of a part or of the whole swelling.

Genuine staphylotomy is fully described, as follows, in Wood's *System of Ophthalmic Operations,* Vol. II, p. 976.

Incision of staphyloma. This operation consists in a division of of the mass in the direction as a rule, of the axis of its longest meridian. According to Fuchs (*Lehrbuch der Augenheilkunde,* 1903, p. 253). Küchler makes the incision transversely across the mass in total staphyloma. After severance, the aqueous humor, with or without a portion of the bulbar contents, will escape, and the walls of the mass will collapse and fall together, forming a foundation for a flattened cicatrix. The parts are to be cleansed. Atropin is to be instilled (care must be enjoined in the use of this drug in elderly subjects and in those few cases in which there is any tendency towards an increased intraocular tension), and the lids simultaneously closed by adhesive strips, or preferably, a carefully applied compress bandage placed over the shut eyelids. The patient is to be placed in bed and kept quiet for a few days' time. The bandage should be changed at every bi daily or daily dressing, and must be worn until the cicatrix has become firm and strong. Demours (*Traité des Maladies des Yeux,* 1818, Vol. I., p. 320), believed that "*l'incision cruciale est bonne, et ne mérite*

pas d'être abandonnée." Stellwag (*Treatise on the Diseases of the Eye,* American Edition, 1868, p. 105), preferred adhesive strips for the closure of the lids "especially in unreliable patients, as a monocular pressure bandage is easily displaced, and is ineffectual, while a binocular one would be unbearable if worn for a length of time." Wardrop (*Essays on the Morbid Anatomy of the Human Eye,* 1808, p. 106), gave a remarkable account of an educated patient, who, having had a spontaneous rupture of an eye affected with staphyloma corneæ, with a consequent lessened prominence of the eyeball, actually repeatedly punctured his cornea with a large needle, until the eyeball assumed a much better shape and became free of inflammation. Later, he rubbed the opposite eye (also staphylomatous), producing a flow of aqueous humor. Since that time, the second eyeball discharged two or three drops weekly, with immediate cessation of all pressure symptoms.

Corneal puncture is said to be of value in thin-walled partial staphylomata which readily collapse, and in which there is but slight incarceration of the iris tissue. Should the lens be wounded, it should be immediately removed. If there is much escape of vitreous humor, or if an extensive intraocular hemorrhage appears, it is best, in most cases, to remove the organ at once, as it not infrequently becomes a source of extremely painful and ofttimes ruinous, suppurative inflammation.—(H. B. C.)

Starblind. Seeing obscurely, as from cataract.

Starch. Amylum. Corn-starch. Amidon. Starch in the form of flour was strewn in the eyes by ancient Greco-Roman physicians as a remedy for ocular ulcers. It was also used in the form of a poultice for ocular ulcers and discharges.—(T. H. S.)

In modern ophthalmic therapeutics, in cases of blepharo-conjunctivitis with undue secretion, finely powdered starch is, alone or with other agents, sometimes dusted on to the conjunctiva. In the same way it is recommended for true eczema of the lids and face. It is also employed like (or with) zinc oxide in ointments.

The starch bandage is a useful appliance in some operations upon and injuries to the eye.

Starch, Glycerite of. See **Glycerite of starch,** p. 5593, Vol. VII of this *Encyclopedia.*

Stare, Postbasic. A peculiar expression of the eyes in posterior basic meningitis due to downward rolling of the eyeball and retraction of the upper lid.

Starlight, Vision by. The *Révue Scientifique* (abstract in the *Literary Digest,* May 3, 1913) remarks upon this subject that the human

eye possesses, as is well known, two sorts of optical receivers—cones and rods. The cones, which alone are present in the central region of the retina, are the organs of color-vision. The normal eye utilizes only these by day, when it sees by "fixing" objects; that is to say, by bringing their images upon this central spot. The rods are spread over all the rest of the retina. They give the sensation of light without that of color and are the only active organs of sight in animals that live in darkness, as also in men who are totally color-blind.

This simple theory, which is due in great part to O. Lummer, has been applied by him to the case of vision on starry nights, and has led him to establish a large number of facts that deserve attention, the more that they can easily be observed by any one.

It should be noted first that it has been definitely proved by photometric measurements that the curve of sensibility to light is very different for the cones and the rods. The curve without color (that of the rods) is identical with that of the normal eye observing indirectly; that is to say, without fixing the objects, so as to utilize the outer parts of the retina, where there are only rods. Measurements show, in the first place, that the region of maximum sensibility is clearly different for the cones and rods. A reddish image will seem gray or black when perceived by the aid of the rods.

Starting from these physical data, Lummer conceived the idea of studying night vision, or, more exactly, vision during the period of transition, when the cones cease to function little by little and give place to the rods.

A first experiment was made in a balloon ascension by night, with a fine full moon. The basket of the balloon was decorated with many-colored pennants. As the eye became adapted to the darkness, the colors of these flags weakened, and finally they appeared quite gray or whitish—a proof that the rods had completely awakened from their diurnal sleep and had assumed the character of organs of vision.

Another experiment was made on a starlit night in the mountains. So long as the eye was annoyed by the neighborhood of electric lights the cones stayed awake and color-vision remained. On the contrary, as soon as the observer got into the shade, the rods began to work. The sky, which had hitherto appeared dotted with only a few stars, was lit up with myriads of them, whitish in tint—the white of the rods. When effort was made to "fix" them, their number and brightness were much diminished, but they all returned and shone as before when regarded indirectly. Lummer succeeded in performing the following astonishing experiment—to look for an instant at the silver crescent moon, then try to fix the gaze on a star near by, and per-

ceive that for several seconds the moon had disappeared from the sky. It is sufficient to have recourse anew to indirect vision by means of the retinal rods, to cause the fugitive celestial body to reappear, with the thousands of stars that the cones alone are powerless to bring to our knowledge.

The *limitation of starlight vision,* especially in the recognition of persons, is considered under **Legal relations of ophthalmology,** in the middle third of the section.

Starmesser. (G.) Cataract knife.

Starrblindheit. (G.) The momentary darkening of the visual field by long-continued staring at a single point.

Starre. (G.) Rigidity.

Stars, Winslow's. Whorls of capillary vessels from which arise the vorticose veins of the choroid coat of the eye.

Static astigmia. Passive astigmatism—as of the lens—not changed by accommodative or other acts.

Static refraction. The refraction of the eye when the accommodation is wholly relaxed.

Stationary cataract. An opacity of the lens of any character, partial and unchanged. One that does not increase.

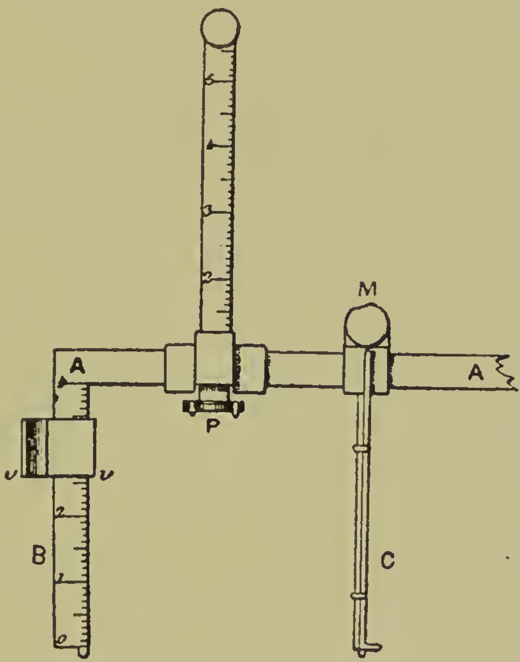
Stationary vibration. Vibration in which the nodes remain at fixed points.

Statistics of blindness. See **Blindness, Causes and distribution of,** p. 1125, Vol. II of this *Encyclopedia.*

Statometer. Exophthalmometer. An instrument used to determine the amount of protrusion of an eye; consisting of a rod or bar with two perpendicular arms or legs of equal length, one of them fixed, the other movable. On the former slides a sight-vane, while on the latter is a mirror. The distance between the arms is made equal to the diameter of the base of the orbit, and the sight-vane is so adjusted that the cornea, its reflected image, and the vane are in the same line. Opposite the eye to be examined, on the cross-bar, is a small, round mirror, in which the eye sees its own image. This mirror, by means of a rod, may be pushed backward and forward upon the cross-bar. See, also, Vol. VIII, p. 4597 of this *Encyclopedia.*

Zehender's statometer consists of a small, rectangular box, with one side open. In this box is a mirror about as wide as the face. When the instrument is placed before both eyes so that the mirror is parallel to the frontal surface, each eye is reflected in it. Small pins, movable by a screw, are so arranged as to stand immediately in front of the centre of the reflected pupils. Their distance from each other may be read off from a scale.

Under the name *statometer,* Snellen has also constructed an elaborate instrument for *measuring the depth of the globe in the orbit.* The figure and legend describing this device are reproduced from Weeks' *Diseases of the Eye.* The author draws our attention to the fact that this instrument may be used to determine variations in individual



Statometer of Snellen for Determining the Depth of the Globe in the Orbit. (Weeks.)

A, bar; *B,* projecting arm, stationary, carrying *v,* a sight-vane; *C,* movable arm carrying *M,* a mirror. The distance between the arms is made to correspond to the diameter of the orbit. The end of *B* is placed on the outer margin of the orbit, about midway; the extremity of *C* on the inner margin of the orbit just below the inner canthus. The sight-vane is so adjusted that the cornea, its reflected image, and the vane are in the same line. The distance from the bar is then read off from the scale *B.* The plunger *P* may then be adjusted to rest on the closed upper lid over the pole of the cornea, and the distance of the plunger from the bar be recorded in millimeters, as indicated by the scale on the plunger.

cases but cannot measure variations in general because the relation of the depth of the orbit to its margins are not fixed and so cannot be standardized.

Statoscope. A sensitive aneroid of special construction, having an abridged scale for measuring minute variations of atmospheric pressure.

Status anaphylacticus. In his experiments on the behavior of traumatic cataract during the specific "status anaphylacticus," de Waela (*Oph. Year-Book,* p. 178, 1916), injected subcutaneously albumen of the lens of the same species or of cattle into guinea-pigs, rabbits and dogs, and studied the effect on subsequent discission of the lens. No

general symptoms were observed but the local phenomena of traumatic cataract were more intense than in the control animal. He believes that in the sensitized animal especial coagulation generators exist, or that the conditions for the formation of coagula are more favorable. In the normal animal the intermediate bodies that cause the intense reactions between the albumen of the new aqueous and the lens fluid or fibers are absent, and hence only a slight coagulation ensues.

See **Anaphylaxis**, p. 339, Vol. I of this *Encyclopedia*..

Status presens. The condition of a patient at the time of observation.

Staubbrillen. (G.) Goggles.

Stauroplegia. Crossed hemiplegia.

Stauroscope. A polariscope to be used with parallel light rays.

Stauungspapille. (G.) Choked disk.

Stavesacre. See **Delphinium consolida,** p. 3811, Vol. V of this *Encyclopedia.*

Steatoma of the eyelids. This tumor, supposed to belong to the class of *dermoids* (q. v.), is not infrequently seen about the lids. As a rule, there is but one, and most usually it is about the outer canthus of the upper or lower lid. The growth of these cysts is slow, and they are due to some injury to the opening of the sebaceous gland. The tumor is round and smooth and varies from the size of a pinhead to that of a hazelnut. It contains broken-down epithelial cells, forming a pultaceous mass. These tumors have well-defined walls. They occur in children as well as in adults. The *treatment* is to incise the tumor, empty it of its contents, and tear out the lining sac. A rapid recovery follows, and a well-done operation in a few days shows no sign of having been performed.—(J. M. B.)

Steatosis, Ocular. Fatty degeneration; more often, a diseased condition of the sebaceous glands.

According to Vollaro (*Archivio di Ottalm.,* p. 661, Vol. XVIII, 1911), some investigations which he has made indicate that in normal senile eyes, and particularly in eyes affected with arcus senilis, there is present a diffuse steatosis of the ocular tissues. This fatty infiltration is found most constantly in the sclera, the corneal periphery, the stroma of the ciliary processes, and the vitreous. It is intimately connected with the senile athero-sclerotic involuntary changes in the arterial system of the eye.

Steeple-skull. See **Tower-skull.**

Steele, Newton C. A well-known ophthalmologist and professor of diseases of the eye, ear, nose and throat in Chattanooga Medical College. Born at Athens, Ala., in 1850, he received the medical degree at the

University of Nashville, Nashville, Tenn., in 1873. For a time he practised at Corinth, Miss., but soon removed to Chattanooga. Here he practised as ophthalmologist and oto-laryngologist until his death—a period of more than thirty years. His only son, Dr. Willard Steele, was a partner with him for the last few years of his practice. Newton C. Steele died of pneumonia, at his home, on March 9, 1919, leaving a wife and two children, Willard Steele and Mrs. W. D. Carswell.—(T. H. S.)

Steinheil's cone. A small solid glass cone, the base of which is convex, whilst the opposite face is concave, occasionally employed to enlarge near objects, by patients suffering from high degrees of myopia.

Stellaria holostea. May-grass. The bruised leaves, the juice, and a distilled water made from this plant have been used as an application to sore eyes.

Stellaria media. Chickweed. All parts of this species are somewhat astringent, and were formerly used in phthisis, hemoptysis, hemorrhoids, and skin diseases; also as an application to wounds, ulcers, and inflamed eyes.

Stellate cataract. See p. 1751, Vol. III of this *Encyclopedia.*

Stellate keratectomy. See **Keratectomy, Stellate,** p. 6751, Vol. IX of this *Encyclopedia.*

Stellulæ vasculosæ Winslowii. See **Stars, Winslow's.**

Stellwag's sign or symptom. An abnormal retraction of the eyelids with diminished blinking. See **Exophthalmic goitre.**

Stenocarpin. A proprietary mixture containing cocain hydrochlorid, salicylic acid, and atropin sulphate. See, also, **Gleditschine,** p. 5579, Vol. VII of this *Encyclopedia.*

Stenocephalous. Having a narrow head.

Stenocharia sacci lacrimalis. (L.) Narrowing of the calibre of the lachrymal sac and nasal duct.

Stenochromy. The art of printing several colors at one impression.

Stenocoriasis. (Obs.) Contraction of the pupil.

Stenopæic. See **Stenopeic.**

Stenopaic. Stenopeic. Stenopæic. Containing a narrow slit or opening. See, also, p. 5396, Vol. VII of this *Encyclopedia.* See **Stenopeic.**

Stenopaic glasses. Stenopeic spectacles. Donders (*Accommodation and Refraction of the Eye,* p. 128) gives a full account of the phenomena seen in the employment of these devices. He remarks that slight obscurations of the light-refracting media, especially those of the cornea, often produce great disturbance of the accuracy of vision. The cause of this is to be sought not so much in the reflection or absorption of a portion of the rays, as in the diffusion of the

light passing through them. This is easily explained. From the entire field of vision rays fall on each local obscuration, and from the latter they spread further in all directions through the whole eye. Consequently in the region of the yellow spot also an image is not merely formed of the object lying about in the direction of the line of vision; but over this image is spread, with the existence of semi-transparent spots, a uniform light, derived from the whole field of vision. This diffused light is very disturbing. Indeed the differences of illumination of the image formed by regular refraction are in consequence much more faintly distinguishable. Just as in looking through a real mist, the diffused light is added to the relatively weaker image, and therefore also spots give the impression as if one were looking through an actual mist: the only difference is, that a mist is more perceptible for more remote objects, and that misty vision, produced by a spot, affects all objects alike, independently of distance. It is well known that obscurations produce much less disturbance when the eye, turned from the light, contemplates a certain object. If a picture or another object be hung between two windows, and if it be illuminated through a window behind the observer, the latter will see the object much more accurately, and with more contrast of light and shade when the two windows are closed than when they are open. The explanation of this fact is to be found in the foregoing. In both cases (supposing that the open windows throw no light upon the object) the object sends, in an equal degree, rays into the eye, which, regularly refracted, form a good image in the region of the yellow spot; but if light falls upon the eyes through the windows placed at the sides of the object, numerous rays proceed, in that case, likewise from the illuminated spots over the image of the yellow spot, which thus becomes covered as with a white crape. Even if there be no spots, some light is always diffused in the eye, and thus even the normal eye will, especially if the time of life be somewhat advanced, perceive, as it were, light crape, when, in the experiment just described, the windows are opened. We know further, that where obscurations exist, exclusion of the peripheric light with the hand, looking through a tube, etc., increases the accuracy of the images. Again, it is the warding off of the laterally incident light diffusing itself from the spot throughout the whole eye, which here acts beneficially. The practical rule hence deducible is this: in order, where obscurations exist, to distinguish with relative accuracy, let the small portion of the field of vision, over which the observation is to extend, be properly illuminated, and let the remaining portion be kept as dark as possible. These reflections on the injurious effect of

obscurations led to the application of stenopæic remedies. Their object is to cut off the light which should reach the obscurations, and through an opening to give, so far as possible, entrance only to the light which is subjected to a regular refraction on the normal part of the refracting surface. The narrow opening is in them the essential part: hence the denomination stenopeic. In order not to limit the field of vision more than is necessary, the opening must be as close as possible to the eye, and with a view still better to keep off all lateral light, it may be surrounded with a wall widening like a funnel. The opening may in general have the form and nearly the size of the clearest part of the portion of the refracting surface corresponding to the pupil: it may, according to circumstances, be round, oval, or slit-like. Rarely will the diameter be less than a millimètre; often it will amount to two or more millimètres.

The stenopeic apparatus, which is an indispensable item in the ophthalmic surgeon's means of investigation, is a very short cylinder, furnished with a handle, open at one end and indented towards the eye, and provide at the other with an opening, in front of which is a diaphragm, containing different smaller openings of various diameters, and capable of turning round, so that each of these openings can be seen in turn. There are also stenopeic apparatus provided with a slit capable of being widened and narrowed. With the aid of this apparatus we can examine whether the stenopeic principle increases the accuracy of vision, which is often of importance in a diagnostic point of view; moreover, we may acquire an indication whether it may be advantageously applied, and what size of opening is the most useful. Of the result obtained we may then make use in prescribing a stenopeic spectacle, or eyeglass. To spectacles for use in the streets, the stenopeic principle is in general not applicable, as the field of vision is too limited. On the other hand, such spectacles to which the requisite glasses have been fitted, are sometimes very serviceable for reading. The chief application of the principle, however, is to the stenopeic eyeglass. Many persons suffering from opacity have recourse to it of their own accord, by warding off the peripherically incident light with the hand, by voluntarily narrowing the slit between the eyelids, etc., in order to increase the accuracy of vision, but this object is always much more perfectly attained by means of a stenopeic eyeglass.

If the part which has remained clear has an oblong form, a slit-like opening will be most suitable. In general, it is a great advantage in reading, when a horizontal slit effects the object; this should, therefore, always be tried. If the opacity is only on one side, we may

obtain a great advantage by making an ordinary spectacle-glass opaque over the obscured part. In general the simplest stenopeic spectacles are those in which the preferable form of opening is left as the only part of the glass not obscured, in which also by opaque matter on the outside the light incident from that point can be warded off. The glass may in ordinary cases be flat, but otherwise according to the necessities of vision it should have a certain focus. In some cases, among others, after the extraction of cataract, there is great advantage from partially covering the glass with black. It is not uncommon, when the flap-section was made downwards, for the inferior part of the cornea to become somewhat turbid, particularly if the iris has attached itself to the wound, or is even slightly prolapsed. The disturbance is the greater, because the pupil too is thereby drawn downwards, and probably the curvature of the cornea is somewhat irregular, so that reading with an ordinary convex glass is attended with great difficulty, or even quite impossible. But it is in the most surprising manner relieved, when the glass is covered to a definite height with an opaque black matter over which the eye sees, while the rays which should reach the inferior non-transparent and irregular part of the cornea, are cut off. This mode of using the glass limits the field of vision only inferiorly, and is therefore attended with no impediment whatever to reading, nor even to vision in general.

Lastly, it may be mentioned (what has reference more especially to anomalies of refraction), that the stenopeic eyeglass has also rendered very essential service in the highest degrees of myopia, particularly when the accuracy of vision has at the same time suffered much. In such cases vision of near objects, at least with one eye, is attended with no other inconvenience than that the object must be brought very near the eye, to 3″ or less. But distant vision is extremely imperfect, and is comparatively little improved by concave glasses, which correct the myopia. If, with their aid, the images are more accurately seen, they at the same time become so much smaller that an amblyopic eye still distinguishes little, and is, therefore, by no means satisfied. In such cases a stenopeic eyeglass with a small opening yields very good service. It here acts in a well-known manner, quite different from that treated of above, by diminishing the circles of diffusion. It is manifest that, in imperfect accommodation, the magnitude of the circles of diffusion increases with the magnitude of the base of the cone of light (the surface of the pupil). Now in high degrees of myopia the pupil is usually very wide, and the disturbance in looking at distant objects is, therefore, relatively very great. Precisely for this reason it is that a stenopeic eyeglass produces so great improvement. If a

myope looks through an opening of from ½''' to 1''' in diameter, he distinguishes at a distance as accurately as through glasses, which imperfectly neutralize his myopia, and he has the advantage that the objects appear larger. If an emmetropic person wishes to convince himself of this, let him hold a positive glass before his eye, so that it becomes myopic, and he will, on looking through an opening, obtain the effect described, and can estimate the partial neutralization of the artificial myopia. In like manner we may also within the nearest distance of distinct vision, by diminution of the circles of diffusion, with the aid of a small opening, distinguish with tolerable accuracy, and thus view small objects much nearer to the eye, that is, under a much greater angle. However, in either case we lose both in light and in extent of the field of vision. As to light, we lose the more the smaller the opening is, and in myopia it is therefore often advisable not to have the opening very small, but with the stenopeic eyeglass to combine a glass which partially corrects the myopia. With respect to the extent of the field of vision we lose the more the farther the opening is from the eye. In combining a negative glass with the stenopeic eye-piece, the patient will therefore turn the small opening towards the eye, when his principal object is to increase the field of vision; on the contrary the negative lens, when he chiefly desires to obtain greater distinctness of vision.

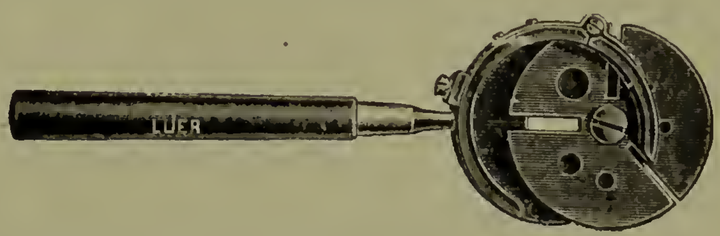
Richardson *(Brit. Med., Jour.,* April 6, 1918) evolved the idea of making use of the *stenopeic slit* in spectacles to wear in the movies. He found them very beneficial. They have been tried and found highly efficient for other purposes than just the movies. They have been tried by pilots and by the captains of several large liners, and they have found that in moonlight or on a sunny day they can see farther with the spectacles than they could without them. The United States Government has made a number of tests, on the firing line and in the aviation field, and the efficiency of the marksman is greatly improved by the use of these spectacles.

Stenopeic. This is probably a more correct form than *Stenopaic.* The word is derived from (Gr.) *stenos,* narrow, and *ope,* an opening. See **Stenopaic.**

Stenopeic lens, Stevens'. A diplopia test for heterophoria. This is a + 13. D. lens, transparent only at its centre where a 3 mm. opening is placed. The lens, placed before the patient's (right) eye, produces a circular disc of light. If the eye muscles are absolutely balanced the normal, left, image of the light occupies the centre of the luminous disk. If not, heterophoria is present, the amount and character of which is determined by the relative position of the two light-images

and the strength of the prism required to bring about normality.

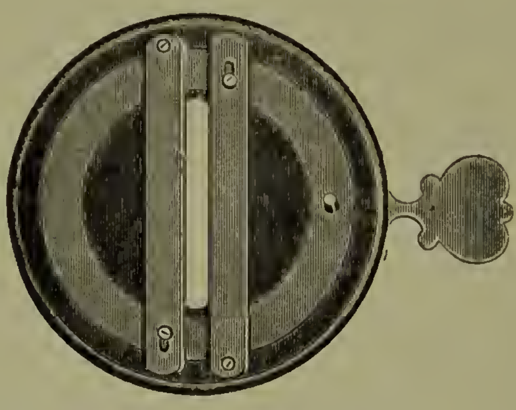
Stenopeic lorgnette. This instrument (see figure) is arranged with three sizes of slits and other openings, in front of which lenses may be placed.



Stenopeic Lorgnette.

Stenopeic slit. An opaque plate with a narrow slit, employed in determining the differences of ocular refraction in various azimuths.

This is one of the devices commonly provided in the ordinary trial case, to be used with the usual trial frame. One of the most useful of these—Gill's—is pictured in the text. It is arranged with movable bars so that any width of slit may be provided.



Gill's Adjustable Stenopeic Slit.

Stenosis of the canaliculi. See **Lachrymal apparatus**, p. 6937, Vol. 14 of this *Encyclopedia*.

Stenosis of the lachrymal duct. See p. 6941, *et seq.*, Vol. IX of this *Encyclopedia*.

Stephen, Peter. A well known Scotch ophthalmologist and Fellow of the Royal College of Surgeons of Edinburgh. He was born in 1829, was for many years consulting surgeon to the Dundee Eye Institution, and died Dec. 5, 1910, aged 81.—(T. H. S.)

Stephens, John Miller. An ophthalmologist and oto-laryngologist of Pasadena, California, who was killed in an automobile accident near

Santa Maria, California, July 10, 1918. He was born in 1879, and received his medical degree at Bellevue Hospital Medical College in 1903. The date of his entry into eye, ear, nose and throat work is not ascertainable. He had been unwell for a number of weeks at the time of his death, and was just starting out on a vacation.—(T. H. S.)

Stereobinocular. A field glass so arranged that the object glasses are farther apart than the eyes, thus giving a stereoscopic effect.

Stereochrome. A stereochromic picture.

Stereochromoscope. A form of stereoscope giving a naturally colored, stereoscopic image of an object.

Stereochromy. A method of pigmentation or painting with water glass as a medium.

Stereo-comparator. An instrument for examining celestial photographs, invented by Pulfrich and Max Wolf (1901). If two plates of the same part of the sky, taken at different times, are viewed first with the right and then with the left eye through a sterescope, and if celestial change has meanwhile taken place, the binocular combination of their images is not perfect. By this method many variables and asteroids have been discovered.

Stereognoscopy. A term suggested by George F. Suker, to define binocular, stereoscopic, perspective vision, i. e., the recognition of solidity and space by sight.

Stereognosis. Perception of the solid character of objects by the senses, especially by handling them.

Stereogram. STEREOGRAPH. A double picture or diagram for producing, by optical superposition of the parts thereof, an appearance of solidity.

A good example of *ocular sterograms* is found in E. L. Oatman's *Diagnostics of the Fundus Oculi*, 1913. Each sterogram is accompanied by a description of the condition depicted.

Stereomicrocamera. Arnold Löwenstein (*Klin. Monatsbl. f. Augenheilk.*, April, 1912) has (through Zeiss) designed a stereoscopic camera which magnifies from 1½ to 5 times. It is an adaptation of the Zeiss-Czapski corneal microscope. A constant source of light is provided by a specially designed arc lamp, which is shaded during focusing. The necessary exposures are short, ¼ to 2 seconds, according to the magnification.

Stereomicrometer. This instrument is (1) an apparatus attached to a telescope so that measurement of small angles in the field of vision may be made by noting the projection on squares by the uncovered eye; also (2) a stereographic measuring-device. See **Stereoscope**, at the end of the section.

Stereomonoscope. An instrument devised by Claudet, consisting of a stereoscope in which, by means of two lenses, two stereoscopic images are thrown upon the same spot of a ground-glass plate. When this glass plate is looked at with both eyes, each eye sees only the corresponding image.

Stereophantoscope. A panorama-stereoscope in which, instead of pictures, rotating (straboscopic) discs are inserted.

Stereophoroscope. An instrument devised by Czermak and used in investigating the theories of visual perceptions with special reference to the effects produced on different zones of the retina. It consists of the ordinary lenticular stereoscope, in which both images are pasted by the side of each other on the same piece of paper. These strips of paper are fastened on the lateral surfaces of a many-sided prism rotating round a horizontal axis. Around the prism, several inches from the images, runs a girdle of pieces of pasteboard in which the necessary openings have been cut. Outside of the girdle is fastened the prismatic combination of a Brewster's stereoscope.

Stereo-photo-duplicon. An instrument giving stereoscopic views by means of a single lens.

Stereophotography. Stereoscopic photography.

Stereophotomicrograph. A stereoscopic photograph of a microscopic subject.

Stereopsis. Stereoscopic vision.

Stereopticon. A pair of matched optical lanterns mounted near to. and parallel with, one another.

Stereo-radioscopy. This subject is discussed by G. Lièvre (*La Presse Médicale,* p. 404, July 9, 1917). He remarks that the subject has for a long time attracted the attention of specialists. The idea of seeing directly on the screen images in relief has in particular interested radiologists. Villard, in France, and Thomson and Mackenzie Davidson, in England, were the first to lay down the principles of radio-stereoscopy, but the difficulties of execution had prevented the employment of this method of clinical examination. However, the writer, with his laboratory assistant, Brion, using the apparatus of d'Arsonval, has been able by mirrors and prisms to obtain stereoscopic views of images projected on the screen. In future, the surgeon will see projectiles in their real position and plane, will know their relation to each other, and will measure the distance in all directions which separates his instruments from these projectiles. The adjustment of a simple commutator will allow him, without moving his patient, to have stereoscopic vision, either from front to rear or from back to front.

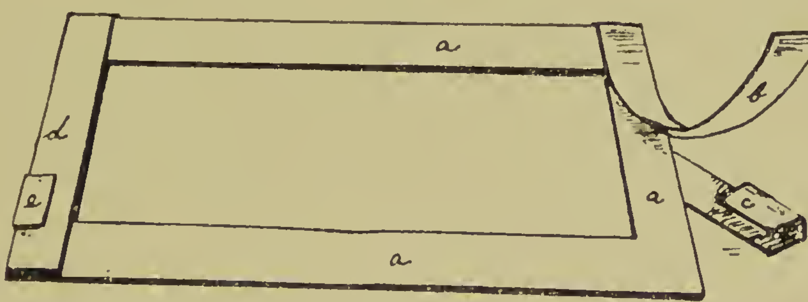
The inventors use indifferently either two ordinary bulbs or one

bulb alone with two anticathodes. The result is better if one has the latter form of bulb. These sources of light, lighted alternately by means of a switch, placed on the secondary, project a double image on the screen. This double image falls on the retina after passing through a shutter formed of two disks revolving in opposite directions, the shutting and opening of which correspond to the periods of illumination. Perfect synchronism between these two operations is obtained by means of a special arrangement.

The apparatus is adaptable to any type of fixed or mobile radiological installation. It allows of the examination in the horizontal position for operations and can be adapted for examinations in the vertical position. Finally, its use presents no more danger for operator or patient than that of the ordinary apparatuses, since each light source is furnished alternately; hence the quantity of rays emitted is no greater than that of a single bulb continuously functioning. One might even claim that the precision of the localizations obtained by stereoscopic vision will prevent many cases of radiodermatitis by shortening greatly the preliminary investigations. The new field offered to the activity of radiologists will be a fertile one.

Stereoroentgenograph. A stereoscopic X-ray picture.

Howard Curl (*Journ. Am. Med. Assocn.*, p. 835, Sept. 13, 1919) says of *stereoscopic roentgenography* that one objection to the use of



Film holder for Holding Films in the Viewing Box in Roentgenography: (*a a*) frame; (*b*) brass spring; (*c*) clip; (*d e*) spring and clip in place. (Curl.)

films has been the difficulty of holding them in the viewing box. This may be done by placing the films between two clean glass plates and securing with spring clips or adhesive tape. If but few cases are handled each week, this method will do very well, but becomes rather irksome if many cases are handled daily.

To meet this objection the writer has made a film holder which is shown in the accompanying sketch. The frame (*a*) is made of galvanized iron. It should be heavy enough not to bend easily. The outside dimensions are the same as those of the film with which the

holder is to be used. Each side and end are from one-half to three-fourths inch wide, depending on the size of the frame and the weight of the material. Across each end is a brass spring (*b*). One end of the spring should bend around the edge of the frame and be riveted on the under side, so that the spring is free from the form on the upper side and will admit the film to the edge of the frame. The other end of the spring is brought down and held with a brass clip (*c*).

These film holders can easily be made by any tinsmith or plumber, and if a number are kept on hand, films may quickly be inserted for the viewing box.

With this arrangement, stereoscopic work may be done just as satisfactorily and easily as with plates, and especially is this true if the double coated or duplitized films are used, as they are stiffer and more easily handled than the single coated film. See **Stereoscope.**

Stereoscope. *(Stereos,* solid; *scopein,* to see; literally, to see solid.) Portions of this subject—of great importance to every ophthalmologist—have already been discussed under several headings in this *Encyclopedia.* See, e. g., **Amblyoscope,** p. 306, Vol. I; **Depth,** p. 3829, Vol. V; **Muscles, Ocular,** p. 7952, Vol. X, *et seq.,* and especially **Physiological optics,** in particular sub-section XXI, p. 10112, Vol. XIII.

The stereoscope is an instrument for blending into one image two pictures of an object seen from slightly different points of view and thereby producing the sense of *relief.*

Historical. The word was coined by Wheatstone in 1838, when he presented to the British Philosophical Association a paper on the Physiology of Vision and exhibited an instrument by which two dissimilar pictures of a solid body could be united to give the appearance of the body itself.

The tremendous importance of this invention justifies a somewhat extended quotation from this paper. "The frequent reference I shall have occasion to make to this instrument will render it convenient to give it a specific name; I therefore propose that it be called a 'stereoscope,' to indicate its property of representing solid figures." Consulting the figures picturing the instrument, "A A′ are two plane mirrors, [whether of glass or metal is not stated] about four inches square, inserted in frames, and so adjusted that their backs form an angle of 90° with each other; these mirrors are fixed by their common edge against an upright B, or, which was less easy to represent in the drawing against the middle of a vertical board, cut away in such a manner as to allow the eyes to be placed before the two mirrors. C C′ are two sliding boards, to which are attached the upright boards D,

D′, which may thus be removed to different distances from the mirrors. In most of the experiments hereafter to be detailed it is necessary that each upright board shall be at the same distance from the mirror which is opposite to it. To facilitate this double adjustment, I employ a right- and left-handed wooden screw, r, l; the two ends of this compound screw pass through the nuts, e, e′, which are fixed to the lower parts of the upright boards D, D′, so that by turning the screw pin p one way the two boards will approach, and turning them the other they will recede from each other, one always preserving the same distance as the other from the middle line f; E, E′ are pannels to which the pictures are fixed in such manner that their corresponding horizontal lines shall be on the same level; these pannels are capable of sliding backwards or forwards in grooves on the up-

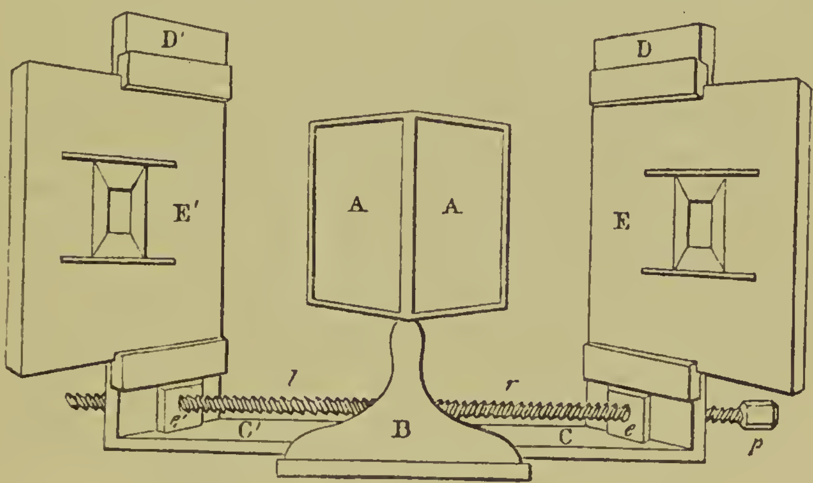


Fig. 1. The Wheatstone Stereoscope.

right boards, D, D′. The apparatus having been described, it now remains to explain the manner of using it. The observer must place his eyes as near as possible to the mirrors, the right eye before the right-hand mirror, and the left eye before the left-hand mirror, and he must move the sliding pannels E, E′ to or from him until the two reflected images coincide at the intersection of the optic axes, and form an image of the same apparent magnitude as each of the component pictures. The picture will, indeed, coincide when the sliding pannels are in a variety of different positions, and consequently when viewed from different inclinations of the optic axes, but there is only one position in which the binocular image will be immediately seen single, of its proper magnitude, and without fatigue to the eyes, because in this position only the ordinary relations between the magnitude of the pictures on the retina, the inclination of the optic axes, and the adaptation of the eye to distinct vision at different distances,

are preserved. In all the experiments detailed in the present memoir I shall suppose these relations to remain undisturbed, and the optic axes to converge about six or eight inches before the eyes.''

The pictures to which Wheatstone applied this instrument were pairs of outline representations of objects of three dimensions, such as a cube, a cone, the frustum of a square pyramid shown as E, E′ in Fig. 1; and he employed them so that there might be no doubt that the entire effect of relief was owing to the simultaneous perception of the two monocular projections, one on each retina.

The discussion of the theory of the instrument was participated in by Brewster, who had that same year presented a paper to the same society in which he established the law of visible direction. Wheatstone argued that ''it is in some degree true'' that the figure is appreciated by successively directing the point of convergence of the optic axes successively to a sufficient number of its points, but that this is not all sufficient and that the mind completely unites or fuses the two dissimilar objects into one. Brewster claimed the all sufficiency of the eyes obtaining the sensation of depth by rapid and successive convergences of the optic axes.

Fig. 2. Elliot's Stereoscopic Drawings.

In 1839 Mr. Elliot, teacher of mathematics in Edinburg, not having heard of Wheatstone's invention, drew binocular pictures which he placed at the end of an open box, which when fused without the aid of lenses gave the appearance of relief. See the cuts.

These pictures are necessarily simple, as stereoscopic photography was not then known, as it is manifestly impossible to *draw* two elaborate landscapes accurately enough for binocular fusion. If with Fig. 2 one allows the eyes to diverge slightly while remaining accommodated the tree is seen in the foreground, the moon in the distance and the cross in the middle ground. This illustrates the principle of

stereoscopy, that the two trees being nearer together than the two moons require a greater convergence to fuse than do the two moons, and that we associate relative nearness with the greater convergence.

While 1838 is the date of the first stereoscope, many of the underlying principles of binocular vision were known to the ancients. Euclid, 300 B. C., stated that pictures of bodies seen by both eyes are formed by each, and demonstrated several problems founded on this theorem.

The idea was also elucidated by Galen 150 A. D. and utilized by Leonardo de Vinci. In 1613 a learned Jesuit, Francis Aguillon in his book on optics demonstrated the theorem "When an object is seen with two eyes, two optical pyramids are formed whose vertices are in the eyes." Between this time and 1838 little practical advance in the subject was made.

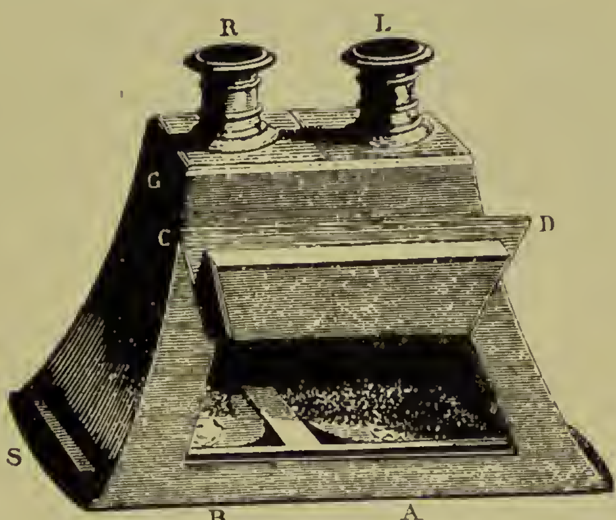


Fig. 3. Brewster Lenticular Stereoscope.

The Wheatstone instrument, on account of its clumsiness and the difficulty in correctly adjusting the pictures, never came into general use. The one of all others to whom the world is indebted for practical stereoscopy is Sir David Brewster. His lenticular stereoscope was invented in 1849.

In 1856 he published a book of over 250 pages which is a classic and has been used freely in the preparation of this brief historical sketch. Not only is the principle of the stereoscope thoroughly elucidated, but there is given complete data for stereoscopic photography, which was manifestly essential as correctly executed pictures were necessary in bringing the instrument into general use. His own description of the instrument is as follows: "This instrument consists of a pyramidal box, Fig. 3, blackened inside, and having a lid, C D, for the admission of light when required. The top of the box consists

of two parts, in one of which is the right-eye tube, R, containing the lens, and in the other the left-eye tube, L, containing the lens. The two parts which hold the lenses, and which form the top of the box, are often made to slide in grooves, so as to suit different persons whose eyes, placed at R, L, are more or less distant. This adjustment may be made by various pieces of mechanism. The simplest of these is a

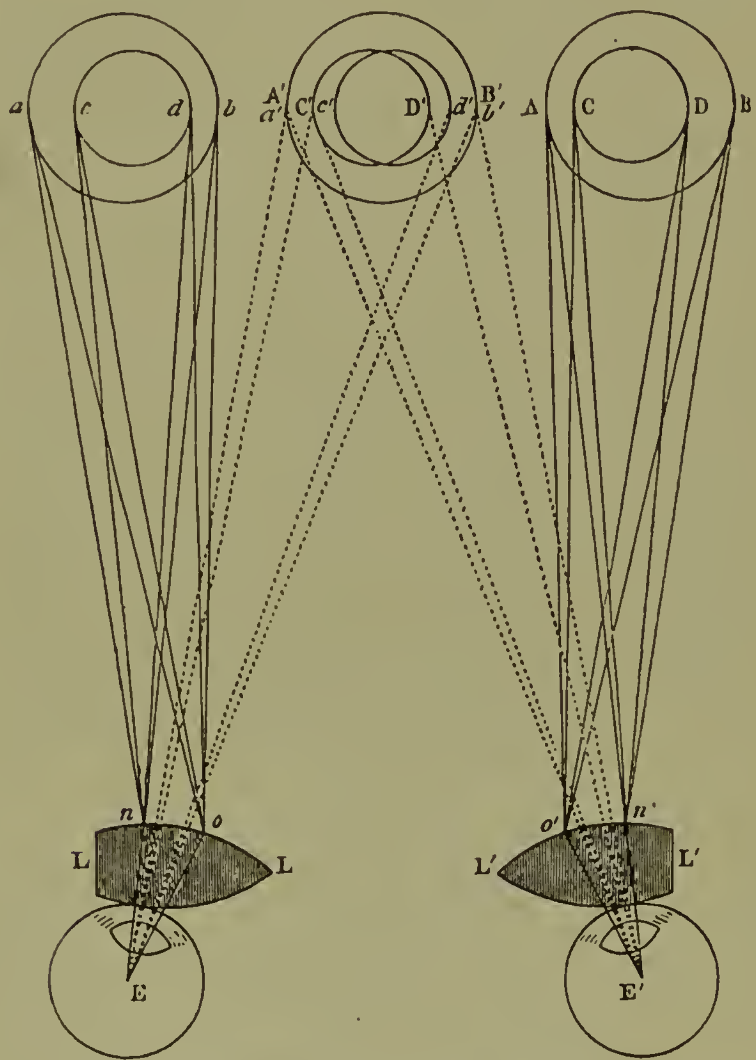


Fig. 4. The Lenses of the Brewster Stereoscope.

jointed parallelogram, moved by a screw forming its longer diagonal, and working in nuts fixed on the top of the box, so as to separate the semi-lenses, which follow the movements of the obtuse angles of the parallelogram. The tubes R, L, move up and down, in order to suit eyes of different focal lengths, but they are prevented from turning round by a brass pin, which runs in a groove cut through the movable tube. Immediately below the eye-tubes R, L, there should be a groove,

G, for the introduction of convex or concave lenses, when required for very long-sighted or short-sighted persons, or for colored glasses and other purposes. If we now put the slide A B, Fig. 3, into the horizontal opening at S, turning up the sneck above S to prevent it from falling out, and place ourselves behind R, L, we shall see, by looking through R with the right eye and L with the left eye, the two images A, B unite in one, and in the same relief as the living person whom they represent. No portrait ever painted, and no statue ever carved, approximate in the slightest degree to the living reality now before us. If we shut the right eye R, we see with the left eye L merely the portrait A, but it has now sunk into a flat picture, with only monocular relief. By closing the left eye we shall see merely the portrait B, having, like the other, only monocular relief. When we open both eyes, the two portraits instantly start into all the roundness and solidity of life."

The lenses, which were 6″ focus double convex very much decentered to secure the necessary prisms, are shown in section in Fig. 4, which he uses to illustrate that when the two larger circles are fused the smaller circles will not coincide until the necessary change of convergence is made.

In 1852 Wheatstone presented a second paper on the Physiology of Vision in which he says: "At the date of the publications of my experiments on binocular vision the brilliant photographic discoveries of Talbot, Niepce and Daguerre had not been announced to the world. To illustrate the phenomena of the stereoscope I could, therefore, at that time, only employ drawings made by the hands of an artist. Mere outline figures, or even shaded perspective drawings of simple objects, do not present much difficulty; but it is evidently impossible for the most accurate and accomplished artist to delineate by the sole aid of his eye the two subjects necessary to form the stereoscopic relief of objects as they exist in nature with their delicate differences of outline, light and shade. What the hand of the artist was unable to accomplish the chemical action of light, directed by the camera, has enabled us to effect. It was at the beginning of 1839, about six months after the appearance of my memoir in the *Philosophical Transactions*, that the photographic art became known, and soon after, at my request Mr. Talbot the inventor and Mr. Collen (one of the first cultivators of the art) obligingly prepared for me stereoscopic Talbotypes of full sized statues, buildings, and even portraits of living persons."

The Holmes or American model of the Brewster stereoscope. It seems to be generally known that Dr. Oliver Wendell Holmes devised the change in the Brewster stereoscope, since known by his name, but

the writer has been unable to discover if he had any interest in the subject other than its educational and cultural value. His son, Chief-Justice O. W. Holmes, informs the writer that he can find no reference to it in his published works.

Fig. 5 shows the eyes slightly converged so that their axes meet far beyond the plane of the pictures, and the fused image is seen at this intersection.

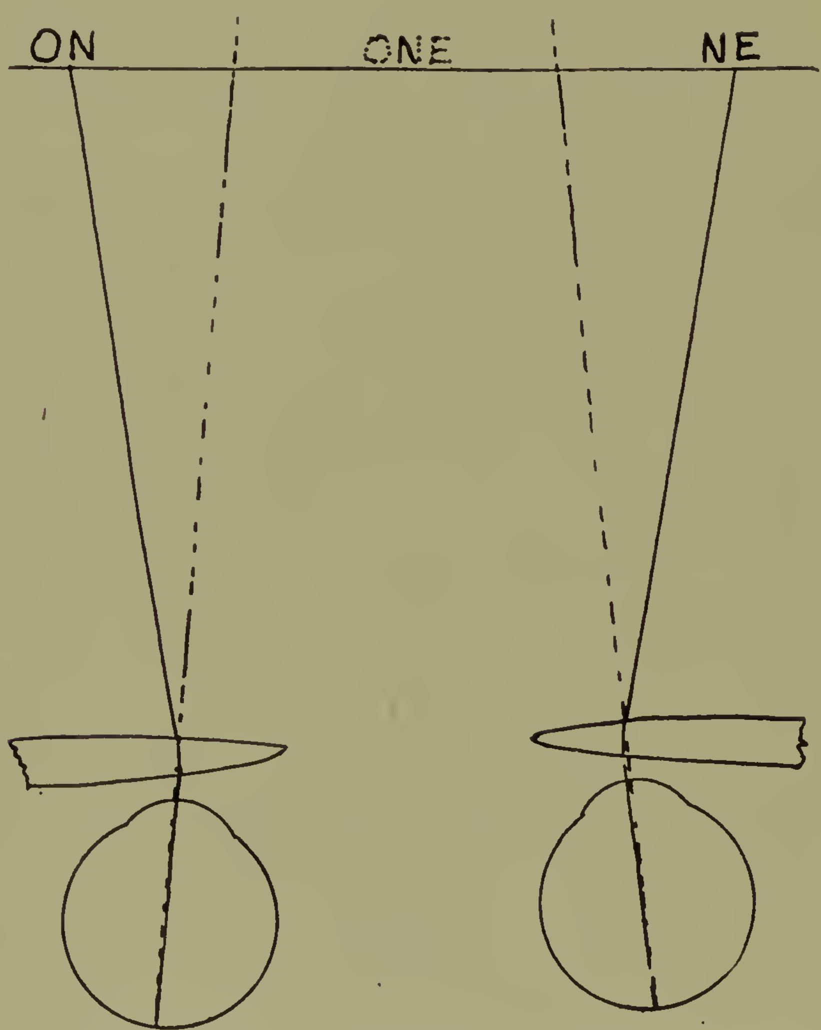


Fig. 5. Formation of the Image with the Brewster-Holmes Stereoscope.

From the files of the *Atlantic Monthly* Underwood and Underwood have reprinted two contributions of Dr. Holmes on the Stereoscope and Stereoscopic Photographs from which a few paragraphs are quoted. "This instrument was invented by Prof. Wheatstone and first described by him in 1838. It was only a year after this that M. Daguerre made known his discovery in Paris and almost at the same time Dr. Fox Talbot sent his contribution to the Royal Society giving

an account of his method of obtaining pictures on paper by the action of light. Iodine was discovered in 1811, bromine in 1826, chloroform in 1831, gun-cotton from which collodion is made in 1846, the electro-plating process about the same time with photography, all things great and small working together to produce what seemed at first as delightful but as fabulous as Aladdin's ring, which is now as little suggestive of surprise as our daily bread. A stereoscope is an instrument which makes surfaces look solid. All pictures in which perspective and

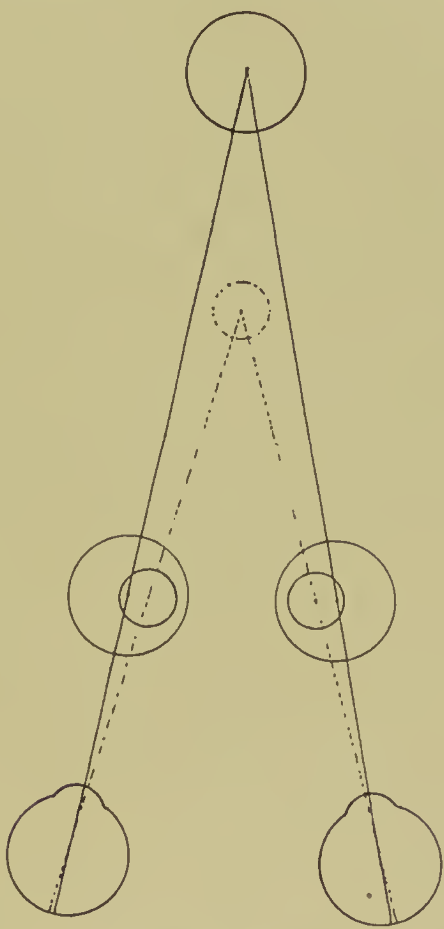


Fig. 6. The Fusion of Decentered Circles.

light and shade are properly managed have more or less of the effect of solidity, but by this instrument that effect is so heightened as to produce an appearance of reality which cheats the senses with its seeming truth. The *stereograph,* as we have called the double picture designed for the stereoscope, is to be a card of introduction to make all mankind acquaintances."

"We write principally to wake up an interest in a new and inexhaustible source of pleasure, and only regret that the many pages we have filled can do no more than hint the infinite resources which the new art has laid open to us all."

In the above is no reference to Brewster notwithstanding the fact that the Holmes instrument is Brewster's device very slightly modified, by giving it a handle and adjustable picture carrier.

LeConte on the stereoscope. Although LeConte invented no new form of stereoscope, his contribution to the subject has been immense. His book on *Sight* appeared in 1881 and was an epoch-maker, because he possessed the faculty of explaining the theory of stereoscopic vision with simple experiments requiring no apparatus. Moreover, being a contribution to Appleton's *International Scientific Series,* it enjoyed a wide circulation. He accepted Brewster's contention that the explanation of ordinary binocular vision and binocular vision with the stereoscope was the same and quotes the statement of Brücke (*Archives des Sciences,* Vol. III, p. 142, 1858). "In regarding a solid object or two stereoscopic pictures in a stereoscope, the eyes are in incessant unconscious motion, and the observer, by alternately greater and less convergence of the axes, combines successively the different parts of the two pictures as seen by the two eyes, and thus by running the point of sight back and forth reaches by *trial* a distinct perception of binocular perspective or binocular relief, or depth of space between foreground and background." This principle is best illustrated by using two simple pictures of decentred circles. See Fig. 6.

The eyes are converged just enough to cause the optic axes to pass through the centres of the larger circles, the images of which fall on the maculæ and the fused image is projected to the distance at which the optic axes meet. In order to fuse the smaller circles the eyes must converge until the optic axes correspond with the dotted lines. Then the fused image of the smaller circles would be projected to a point nearer the observer.

In order to give a perfect frustrum of a cone a few radial lines should be drawn connecting each smaller circle to the larger. In order to make the larger end of the cone seem nearer the smaller circles should be decentered outward, in which case they would require less convergence.

Dove's experiment. The instantaneous perception of binocular relief of a natural scene or two stereoscopic pictures when viewed by an electric spark, the duration of which is only $\frac{1}{24000}$ of a second (Dove's experiment, see p. 4073, Vol. VI of this *Encyclopedia*) was evidence to LeConte that the change of convergence could not account for all the facts and he therefore concludes that "each eye, as it were, knows its own image, although such knowledge does not emerge into distinct consciousness, that the mind perceives relief *instantly* but not *immediately,* for it does so by means of double images."

Hyslop (*Mind*, No. 52, p. 499) discussed the question in the nineties stating that "The localization of stereoscopic figures corresponds exactly with the kind and degree of adjustment required to produce fusion." In agreement with LeConte he believes in a "Psychic synthesis." Parinaud (*Annales d'Oculistique*, 1904) objects to the conception of Brewster and Brücke and insists that the fusion of stereoscopic pictures is not identical with binocular single vision because in the former "Stereoscopic vision is obtained not by the fusion of the figures themselves but by the fusion of the virtual images of the figures."

Stereoscopy has found a wide field of usefulness besides the educational and cultural value so enthusiastically described by Dr. Holmes. Perhaps not generally known is its application to solid geometry, in which many students find great difficulty in comprehending the third dimension from the perspective drawing. Its value in anatomical illustrations and in interpreting skiagraphs has been demonstrated more recently.

The superposition of two transparent images was used by Dove to distinguish the original from a copy. This principle is applied in detecting counterfeits of all kinds and when the stereoscope is used for this purpose it is called a stereocomparitor. The *stereotelemeter* was developed in 1899 from the *telestereoscope* of Helmholtz. It is used for measuring the distance away of natural objects and should be described under a separate caption.

A simple cataloging of the different arts and sciences in which the stereoscope plays an important rôle would require much space, while this article is limited to its application to ophthalmology.

Kayser's stereoscope. Kayser has constructed an improved stereoscope in the form of a rectangular box hinged to a supporting board, capable of being placed at any angle by means of a wooden support, so as to adapt it for persons of different height when seated at a table. Half of the cover of the box is hinged, and carries on its inner surface a reflector for illuminating the picture.

STEREOSCOPE IN OPHTHALMOLOGY.

It must early have occurred to ophthalmologists that the stereoscope might be utilized in the treatment of heterotropia and heterophoria. To whom belongs the honor of first suggesting it is not known to the writer. An attempt has been made to arrange the subject in some chronological order, but this is manifestly imperfect. Quite similar

pieces of apparatus have been devised by those working independently, and it is possible that important inventions have been omitted.

This treatment was first attempted by the use of special cards with pictures designed to interest the young. Sets of such cards were devised by Dahfeld, Kroll, Perlia and Javal and recently by Underwood and Underwood. In later editions of Dahfeld and Kroll there were provided adjustable pictures which could be approximated or separated to suit heterophoric cases, which were and are of great value. The adjustment was insufficient for testing heterotropia.

Green (*Trans. Am. Ophthal. Soc.,* 1889) presented a series of charts, the stereoscopic fusion of which gives very vivid perspective effects, which would not be suspected until fused. Green, Jr., (1919) has turned over to the writer what remains of the set, but does not know if any practical use was made of these charts in training the fusion faculty.

Landolt's model of the stereoscope. When visited by the writer in 1900 Landolt was using a box stereoscope which he describes and illustrates in his *Refraction and Accommodation of the Eye,* English edition, 1886, p. 409. It is also pictured in Norris and Oliver's *System of Diseases of the Eye,* Vol. IV, p. 108.

He states that "We employ for the re-establishment of binocular vision a very simple apparatus (Fig. 7). It consists of an ordinary stereoscope box, from which we have removed the prisms, in order to substitute for them whatever glasses from the trial-case may be desirable, whether spheric, cylindric, prismatic, or a combination of them.

"It is well to make the partition of the stereoscope rather long in order to prevent one eye from trespassing on the visual field of the other. The visual objects placed at the opposite end of the box from the eyes to be exercised, may be brought nearer to or separated from each other at will. They may even be raised one above the other, or inclined relatively to each other.

"The principle of any stereoscope useful for the treatment of strabismus is that the instrument employed places the eyes in the conditions which are most favorable to the fusion of their retinal images.

"One of the eyes being generally weaker, or in any case less exercised, than the other, it is a question, first of all, of making its visual impressions as vivid as possible. For that purpose we correct its astigmatism and adapt it with perfect precision to the distance of the object which it is to see, in order to procure for it an absolutely clear retinal image. After doing so, we must seek the relative position of the two figures in which their fusion is possible.

"Let us take, for example, our stereoscope and place the test ob-

jects at a distance from each other approximately equal to that between the two eyes. Under such circumstances their fusion into one single impression necessitates the parallel direction of the eyes. Knowing that this parallelism is generally possible only in the absence of any accommodative impulse, we provide the patient's eyes, or the sight-holes of our stereoscope, with glasses which permit him to see at the distance of the objects without any effort of accommodation.

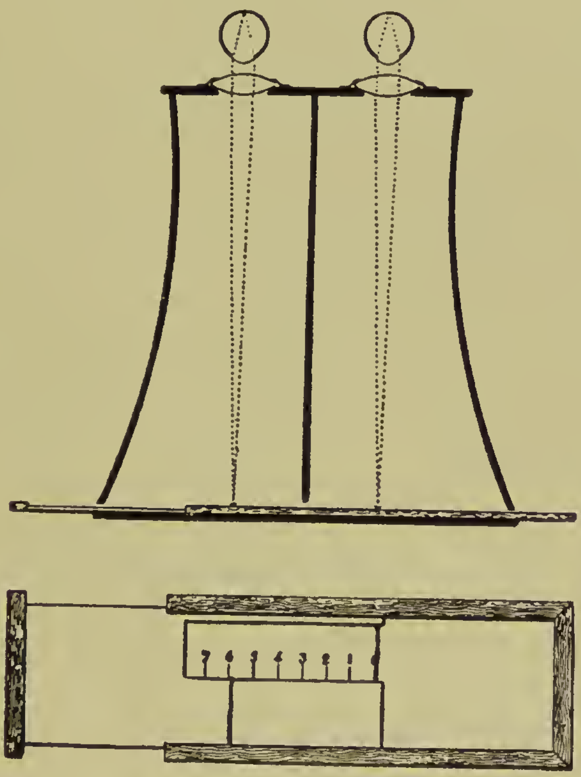


Fig. 7. Landolt's Stereoscope.
(Courtesy of the J. B. Lippincott Co.)

Fig. 7. Landolt's Stereoscope. The upper part of the figure represents the stereoscope box furnished with glasses which adapt each of the two eyes to the distance of the visual objects.

These latter are fixed to two boards which slide one upon the other in such a way that one can alter at will the distance between the two figures. This distance is indicated in millimetres by the division of one of the boards.

The figures to be fused are represented here by two simple red lines, the one corresponding to the point zero, the other to the sixth centimetre of the division.

"Ordinary stereoscopes being generally about 166 millimetres (1/6 metre) deep, emmetropic eyes would require convex 6 D. to fulfill this condition. If we have to do with a hyperope of 4 D., we shall give him convex 10 (4 D. to correct his hyperopia and 6 D. more to adapt him for 166 millimetres).

"It will be noticed, however, that even under such circumstances the majority of patients do not succeed in fusing the images. This

may be due merely to incapacity to direct their eyes parallelly. We then help the patient to find the distance between objects which is requisite for the fusion of their images. When he has succeeded in doing this, we shall gradually separate the objects more and more until fusion is effected with perfect parallelism, or even slight divergence of the lines of fixation.

"But the greater part of the time the patients do not fuse, whatever may be the interval between the two objects. They see alternately the one or the other, when the vision of the one eye is about as good as that of the other, or only the object corresponding to the better eye when the vision of the two eyes is different.

"In this case it becomes a question of attracting the attention of the weaker eye to the object which corresponds to it, to cause it to fix energetically, excluding its congener. By successively covering and

Fig. 8. Landolt's Fusion Tubes.

uncovering the better eye for longer or shorter intervals indeed, even by furnishing it with a too strong convex glass which lessens the clearness of its vision—one may succeed in causing the patient to see the two objects simultaneously, and at length to fuse them into a single one. Much patience is required, in order to achieve this result, on the part of the surgeon as well as of the patient. It is for this reason that this training, so logical and useful, is far from having found in ophthalmic practice the place which it deserves."

To facilitate this training and to overcome the tendency to suppress one eye he devised a pair of *fusion tubes* with translucent pictures on different shades of smoked glass, so that the suppressed eye could be encouraged by giving it the brighter picture.

Javal's stereoscope. Javal's *Manuel du Strabisme* (1896) was the

first practical manual on fusion-training. His stereoscope, with five adjustments, made it possible to execute the movements essential to the successful stereoscopic treatment of "latent strabismus," better named by Stevens, heterophoria. To him we are indebted for the sug-

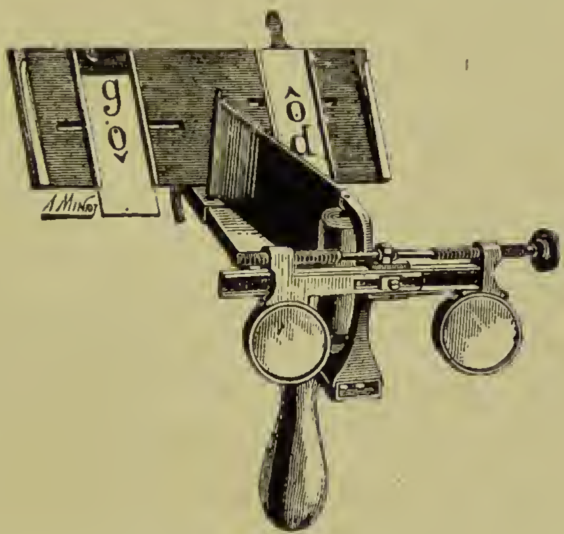


Fig. 9. Javal's Stereoscope of Five Movements. (Courtesy of the J. B. Lippincott Co.)

gestion of decentering + 10. D. lenses to insinuate the prismatic element while the patient is watching the fused image.

Of equal value are the graded cards which he devised, and for the use of which such exact detailed instructions are given. This stereoscope could not be adapted for true strabismics, and although he sug-

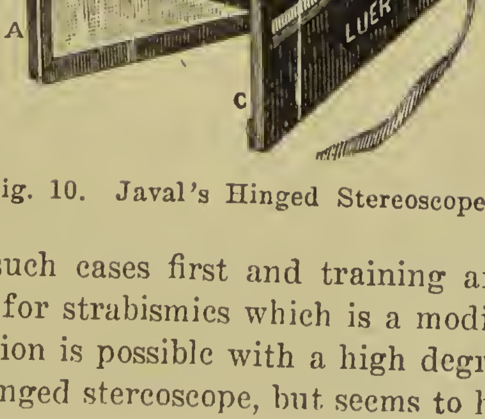


Fig. 10. Javal's Hinged Stereoscope.

gests operating on such cases first and training afterwards he illustrated a stereoscope for strabismics which is a modification of Wheatstone's by which fusion is possible with a high degree of heterotropia. This he called the hinged stereoscope, but seems to have used it chiefly

as a stereoscopic strabometer, devised for the subjective determination of the squinting angle. Around a vertical hinge two mirrors may

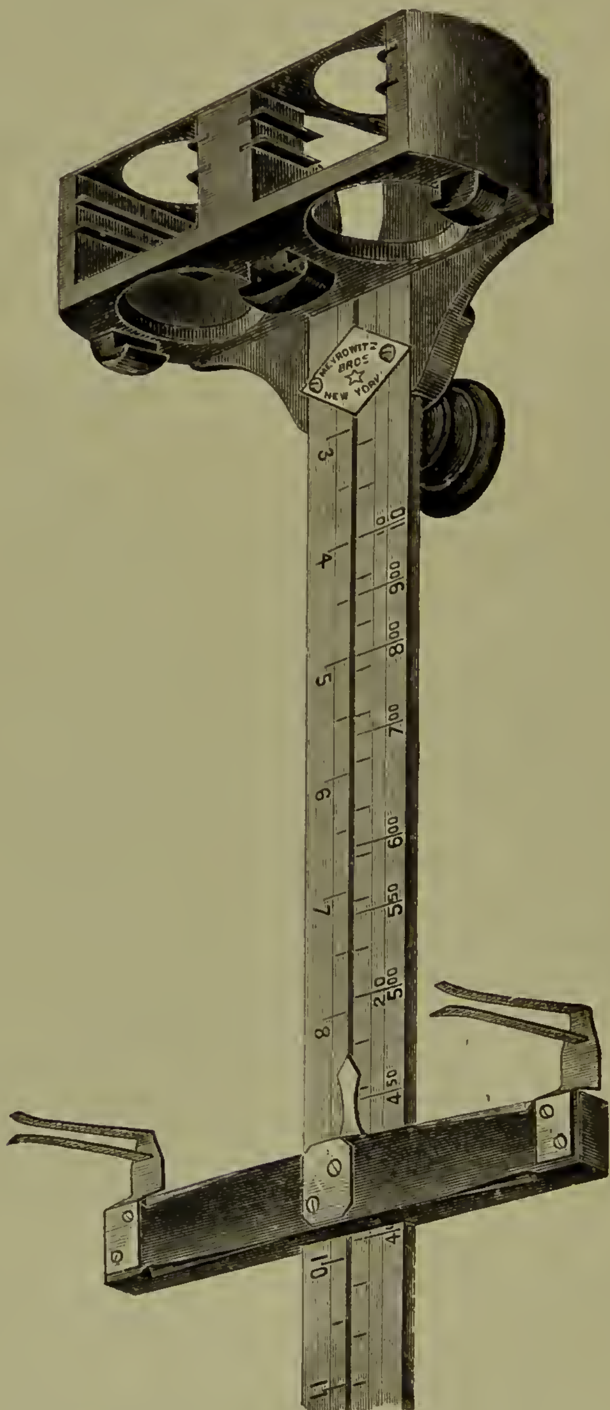


Fig. 11. Noyes Prism Holder.

be rotated. Each of these mirrors is firmly fastened at its other end at an angle of 45° with a plate or tablet. Upon the inner surface of the latter are placed the objects of fixation, which are to be reflected

by the mirrors. If an observer looks with one eye toward one mirror and the other toward the other, then by a proper arrangement of the angle of the hinge he can fuse the two reflected images. If this angle is 90° the eyes must stand parallel, if it is greater than 90° they must diverge, if it is smaller they must converge, in order to see binocularly. The position of the mirrors in which each eye is directed toward one of the images is thus formed, and the included angle may be read off on a graduated arc.

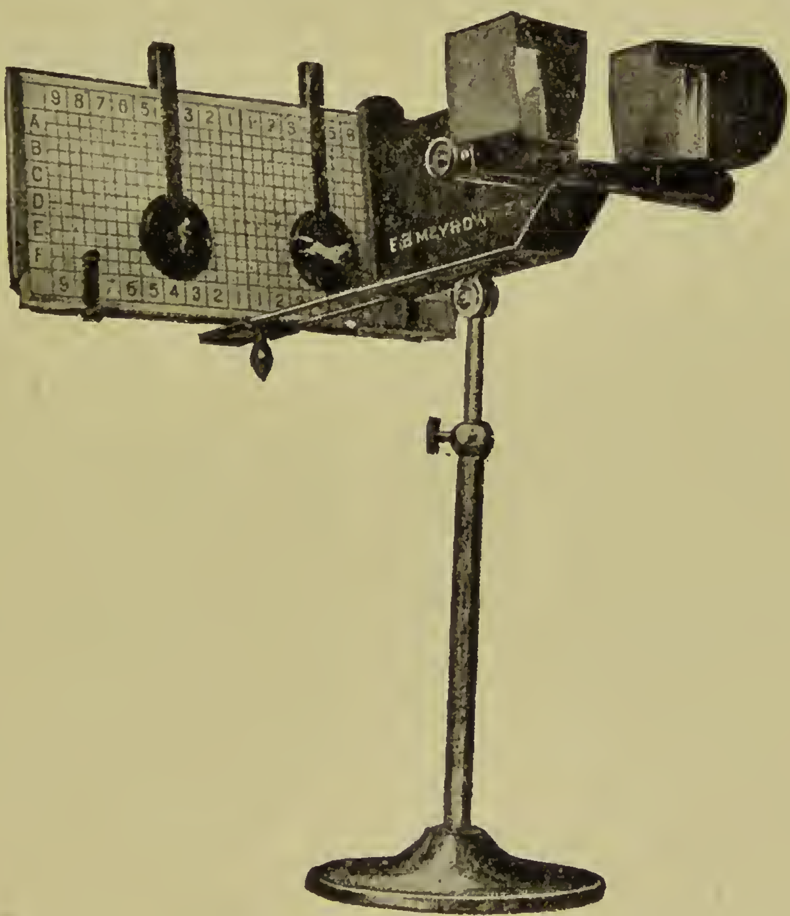


Fig. 12. Derby's Simplified Stereoscope, for the Orthoptic Treatment of Strabismus.

Stevens adjustable stereoscope. W. LaConte Stevens (*Amer. Jour. of Science*, 1882) published a description of an *adjustable stereoscope.* The attachment consisted of a device that enabled the observer to separate or approximate the half lenses in their usual positions, bases out, to suit different degrees of convergence tendencies. To secure reverse perspective, prisms could be removed and placed bases in. The mechanism seems rather crude compared with the right and left endless screw of Brewster and of the modern phoro-optometer stereoscope or the Richard Derby model.

Noyes prism holder. About this time the Noyes prism holder enjoyed considerable popularity.

When used as a stereoscope the required lenses and prisms were selected from the trial case. This individual adjustment can now be made much more quickly and accurately with the phoro-optometer.

The Derby stereoscope. Derby (*N. Y. Eye and Ear Infirmary Reports,* 1898) describes his instrument as follows: "The stereoscope is mounted on a firm base, and it as well as the object card can be inclined to any required angle by a movable joint, and the whole thing can be elevated at will. The distance between stereoscope and object card can be increased or diminished, by a simple mechanism, between 12 and 16 cm., the normal distance being 13 cm., the focal length of

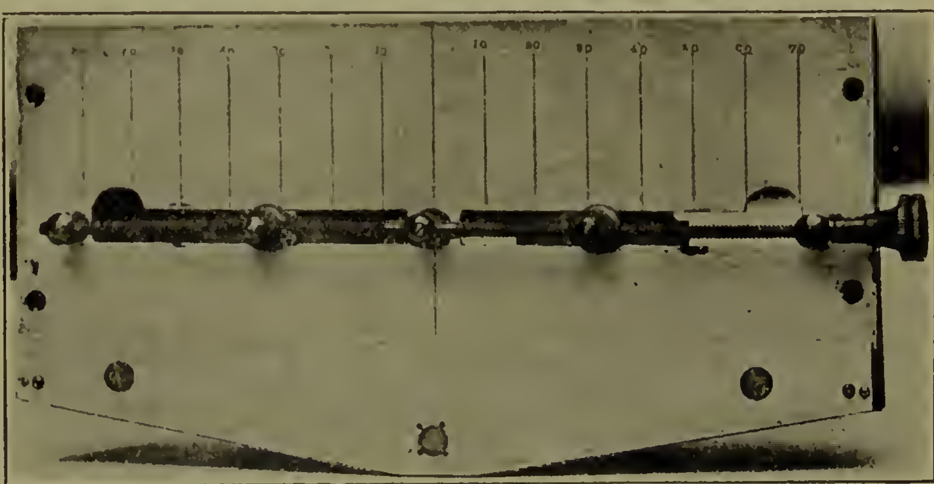


Fig. 13. Back of Card Holder of Wells Phoro-optometer Stereoscope. First model.

the convex prisms. These lenses are convex 7 D. combined with prisms 5^{Δ} bases out. To meet varying pupillary distances, these lenses may be displaced laterally by means of a simple screw adjustment set in the framework of the stereoscope.

"The background for the half-pictures is a white surface on which horizontal and vertical lines are engraved, each case at a distance of one centimetre apart. These vertical lines are numbered right and left from the middle of the card. Experience has shown that the measure of displacement of the half-pictures, one square on the card or 1 cm., is a prism of 3^{Δ}. Directly in front of this white background, which thus serves for an exact location of the two half-pictures, two small travellers move. Each of these, like the half of an ordinary trial frame, is semicircular and is graduated from 0° to 180°. In this traveller the stereoscopic half-picture is placed and the vertical axis

of the picture for ordinary muscular anomaly is placed at 90°. By a simple screw adjustment, the two images may be moved in either a lateral or vertical direction.''

This feature of the instrument was omitted in the simplified stereoscope (Fig. 12) and the half-pictures moved by hand. As the illustration of the first model has been lost, a cut of the back of the first Wells stereoscope (see *infra.*) is here presented (Fig. 13), as this shows the endless screw which was copied from Derby.

This hand adjustment is clumsy and must have detracted from the practical value as the eyes will not follow the fused image unless the movement is smooth and steady. The simplification was undoubtedly made for the sake of economy and not for efficiency.

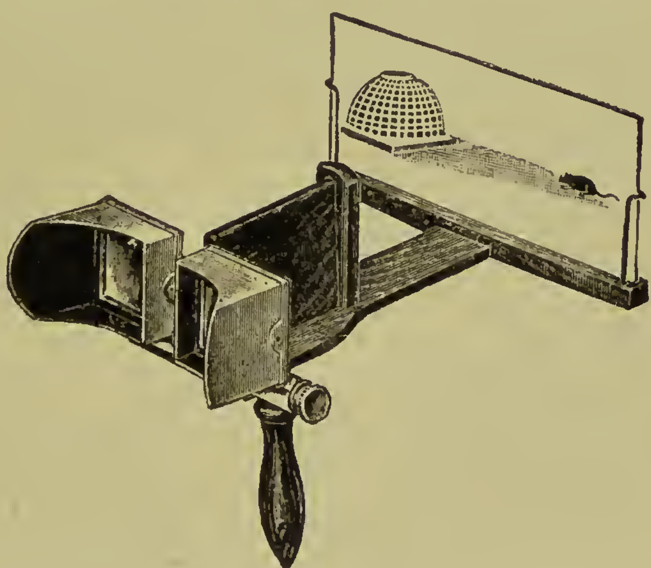


Fig. 14. Stereoscope with Adjustable Pupillary Distance.

This is a further simplification of the Derby and is cheap enough to admit of being purchased by the patient for home use. It would be much more useful if supplied with clips for extra prisms (see Fig. 25).

Worth's amblyoscope. For the treatment of strabismus we are greatly indebted to Claude Worth, who in 1901 brought out a pair of fusion tubes with mirrors, so hinged that they can be approximated for an esotropia of 60° and diverged for an exotropia of 30°. This device he called the *amblyoscope* (see Vol. 1, p. 306 of this *Encyclopedia*).

Black added to this a vertical adjustment which is superior to Worth's method of correcting a troublesome hyperphoria with a vertical prism from the trial case.

This instrument has revolutionized the treatment of heterotropia,

and been the means of curing many cases of esotropia, and saved thousands from developing *amblyopia ex anopsia.* It is not too much to say that one who has not mastered Worth's *Squint* is not qualified to treat a case of heterotropia. This is our excuse for quoting the Worth's directions for the use of the amblyoscope in the orthoptic treatment of squint. "The child with his correction on, is held on the surgeon's knees and the amblyoscope roughly adapted to his degree of deviation; it is then held before the child's eyes and an electric lamp is put in the axis of each tube about four feet away. By a simple mechanical arrangement each lamp is easily brought nearer to, or put farther away from the tube which it illuminates. A slide

Fig. 15. The Worth-Black Amblyoscope.

showing a cage, for instance, is put in the tube before the child's fixing eye, and a bird in that before the squinting eye, and the child is told what to look for. At first he sees only the cage. The lamp before the fixing eye is then taken farther away and that before the squinting eye is brought nearer until the child sees the bird. By this time he has lost sight of the cage. The child is then allowed to grasp the instrument, and assisted by the hands of the surgeon, is taught to vary the angle of the instrument so as to make the bird go in and out of the cage. Many other similar pairs of slides are shown. The average child of 3½ or 6 years of age takes a very keen interest in the game which he imagines has been devised merely for his amusement. Slides which require a true blending of the images are then shown. After a time

it is often found that the angle of the instrument may be altered to a very considerable extent, either in convergence or divergence, while the eyes follow the objects and maintain fusion of the pictures. One often gets a powerful 'desire' for binocular vision in these young subjects with surprising facility. The next step is to equalize the intensities of the lights. This may usually be done at this stage without a return of suppression. In many cases one is able to deviate the two halves of the amblyoscope more and more at each visit until parallelism of the visual axis is obtained.''

Bradburne's stereoscopic fusion trainer. This consists of a Holmes stereoscope with a screw for moving the object carrier. If a patient

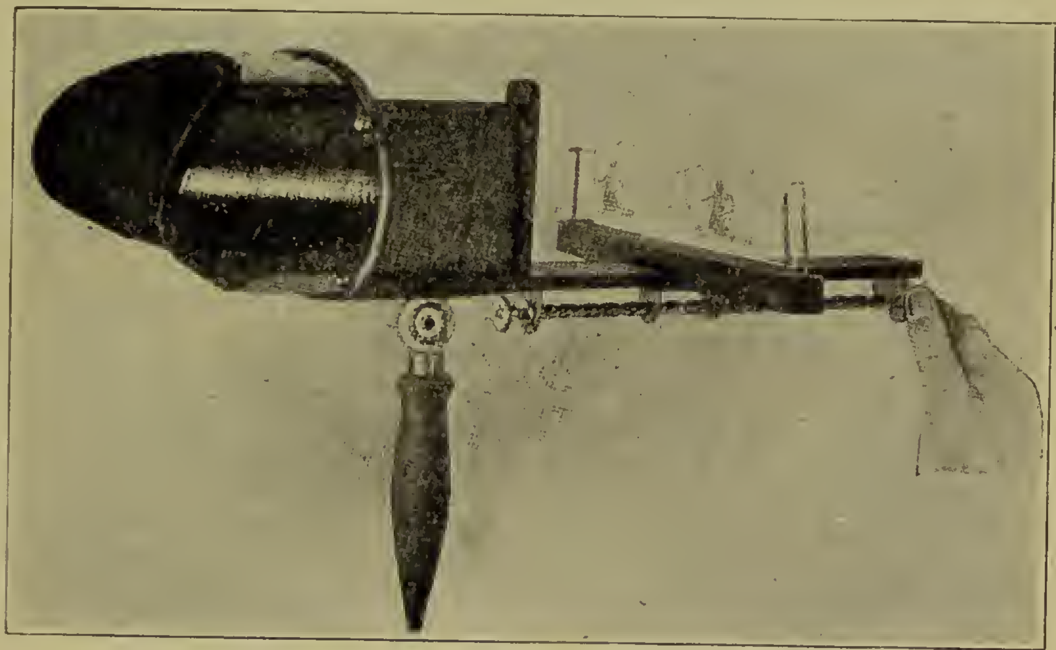


Fig. 16. Bradburne's Stereoscopic Fusion Trainer.

be exophoric he will prefer to have the carrier farther off than an esophoric. When fused at the best position, if the carrier is brought nearer, his convergence would be exercised. This is better accomplished by the author's clips for additional prisms described later.

Bishop Harman's diaphragm test. The instrument of N. Bishop Harman (see Vol. II, p. 976, and Vol. IV, p. 4703 of this *Encyclopedia*) should perhaps be included in this section, although he has furnished no cards which show perspective, and therefore his instrument is not strictly a stereoscope, but it can be so used with cards showing decentered circles, the fusion of which gives a very vivid cone frustrum. This fusion is accomplished by looking at the left picture with the right eye and the right picture with the left eye. Unless one be esophoric this will require the use of a prism base in and the required

strength is not easily determined. The cone appears to be in front of the pictures, where the visual axes cross, instead of beyond as in other forms of stereoscope.

This test is the reverse of Javal's well-known "Bar-reading" test. (See p. 884, Vol. II of this *Encyclopedia.*) Instead of a bar, which the patient's eyes must negotiate, there is a screen with a single hole in it; through this hole the patient can look with both eyes quite naturally and without suspecting the test to which his vision is being subjected. The instrument is made of wood, like a flat ruler, 44 cm. long, fitted with a rack at one end to receive the test cards, and a screen measuring 9 x 6 cm. fixed at 11 cm. from the rack. In this screen, or diaphragm, two holes are cut, one, 1.7 cm., square; the other, round, 1.7 cm. diameter. In making tests, either the square or

Fig. 17. Harman's Diaphragm Test.

round opening may be employed. A movable pin is fixed to the diaphragm so that it can be projected into the opening as a point of fixation in certain experiments. A handle is fixed beneath the baseboard.

The patient takes hold of the handle with both hands and places the free end of the rule (this is washable) against the upper lip, just beneath the nose. The operator stands facing his patient and holds the other end of the instrument to keep it steady. When the instrument is in position the patient is asked to look either through the hole or at the pointer projecting into it, according to the test desired, and to tell what he sees through the hole.

There are three kinds of test cards that may be used with the diaphragm test: (1) Printed matter of any size from diamond in set paragraphs to canon in paired capitals. (2) Black or colored squares

variously disposed. (3) Pictures for children. A number of test cards are issued with the instrument, but the surgeon can make and vary them indefinitely.

The screen with the square hole is most generally useful for the reading tests particularly and when we wish to demonstrate the presence of binocular vision where it is denied. When the patient looks clear through the hole at the test the margins of the hole are seen doubled, the square becomes an oblong; this change escapes remark save by the most observant. On the other hand when it is desired to demonstrate weakness of binocular vision, or in fusion experiments, the round hole is the better, as reduplication of the circle and overlapping of the two images is very noticeable.

The diaphragm test is of value for the following purposes: 1. To determine the equality of visual acuity in the two eyes. 2. To determine the presence, the absence or a defect of binocular vision. 3. To exercise the vision in squinting eyes. 4. To detect malingerers feigning monocular blindness. 5. To demonstrate certain physiological phenomena connected with the perception and suppression of images.

Stereoscopic treatment of heterophoria. As far as known to the writer Javal was the first to use the stereoscope in the treatment of "latent strabismus" or heterophoria as outlined in his *Manuel du Strabisme,* 1896. It was his stereoscope with five adjustments that suggested to the writer the phoro-optometer for the same purpose. Javal's charts, graded from easy to difficult, opened up an entirely new and practical field in fusion training. In 1904 some of these were reproduced in English by the writer in the "Wells Selection of Stereoscopic Charts." Most of the other charts, like Kroll's, Dahlfeld's and Hale's, were adapted to secure only the rudiments of binocular vision.

Wells phoro-optometer stereoscope. Doubtless much good work can be done with an ordinary stereoscope, but to carry out the writer's methods one should have a phoro-optometer, with two rotary prisms and the stereoscopic attachment. The phoro-optometer had been in constant use several years before its adaptability as a training stereoscope was discovered.

The first apparatus was made with an adjustable focus so that spheres from + 5.00 to + 10.00 D. could be used. This was later discarded and a permanent distance of 10 cm. adopted. With this + 10 D. spheres are always in focus.

Following the Derby model, adjustable object carriers were provided, with somewhat elaborate mechanism for vertical adjustment and an endless screw for approximating and separating them. This was

essential to secure a gradual and smooth movement, otherwise the eyes ceased to follow and fuse the two objects.

After using this arrangement some time, it was discovered that patients who found great difficulty in keeping the objects fused as the carriers were approximated, were much less disturbed if the spheres were separated by turning the screw for pupillary adjustment, and that a much greater degree of prism could in this way be fused.

The 1902 model of the Wells stereoscopic attachment to the phoro-optometer (Fig. 18) shows the movable object carriers, but in the author's instrument they soon became fixed 6 cm. apart.

It was later discovered that if one were a little careless in fixing the objects in the carriers, a slight tilting or vertical error interfered

Fig. 18. The Wells Phoro-Optometer Stereoscope with Adjustable Object Carriers.

with fusing, so the object carriers fell into disuse and stereoscopic cards were used instead. The improved form is, therefore, simply the addition to the phoro-optometer of a clip to hold the cards. See Fig. 19.

In 1904 the Wells selection of stereoscopic cards was published. This was a selection of the most useful from those previously brought out by Kroll, Dahlfeld, Hale and Javal. Only a few new cards were added by the author.

These have gone through three editions. The later editions include some ingenious tests in fusing complementary colors by Dr. George A. Shepard, of New York, several new cards in the perspective series and a new set for amplitude training, by the author. The lettering and grading have been somewhat changed.

To guard against any misunderstanding the reader should bear in

mind that in the instructions which follow, the letters and figures refer to the third edition.

The *application of the principle of decentering of the spheres for the purpose of introducing extra prismatic effect,* as applied to fusion

Fig. 19. New Phoro-Optometer Stereoscope Showing Simple Clip to Hold Cards. (Wells.)

training, is believed to be original with Javal (*Manuel du Strabisme,* p. 115), but it has been greatly extended by the writer, and its su-

Fig. 20. Card to Measure Fusion Convergence.

periority over any other method known to him justifies a somewhat detailed description.

With o. u. + 10., cards at 10 cm. are in focus. If the separation corresponds to that of the pupillary distance of the patient's eyes, no

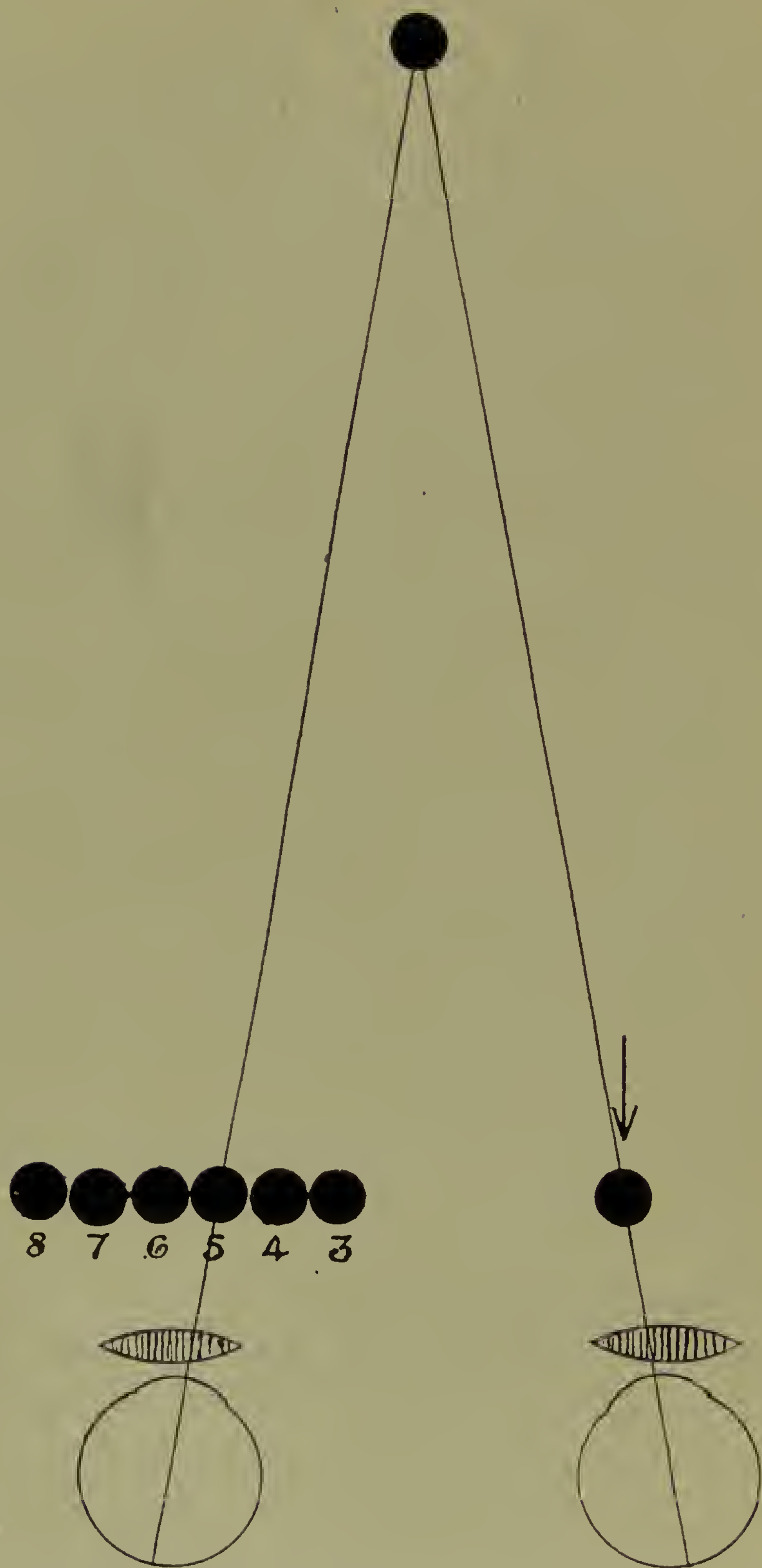


Fig. 21. Showing the Lines of Sight When the Patient Sees the Arrow Over 5.

prismatic element is exhibited. If decentered 1 mm., 1^{Δ} approximately is produced. Thus + 10. spheres make the calculation of the prism extremely simple. If the spheres are decentered out 5 mm., we have put before the patient 5^{Δ} of prism base out, just as truly as though a 5^{Δ} prism were inserted in the clip. If the spheres are decentered *in* 5 mm., 5^{Δ} base in is obtained. As the pupillary adjustment may be varied from 50 to 75 mm., it follows that 10^{Δ} or more may be utilized by this simple principle of decentration.

The phoro-optometer enables one to adapt the stereoscopic principle to each patient's phoria, which is very important in cultivating fusion. Incidentally, it demonstrates how the patient's eyes tend to turn when used together for near. If the B3 card shows any hyperphoria this is corrected with a prism from the trial case.

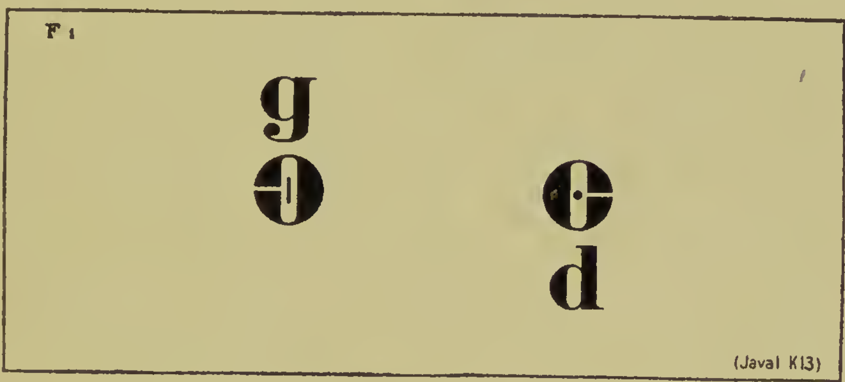


Fig. 22. Stereoscope Card Numbered F_1.

Stereoscopic treatment of exophoria and convergence insufficiency. Let us suppose a case of exophoria of 10^{Δ} distance, adduction subnormal, greater convergence faculty needed. With o. u. + 10. in the clips, centered to correspond to the patient's pupillary distance, card marked B_1 is put in the clip, and the patient is asked over which dot he sees the arrow. He will probably answer "five" or "between five and six." In five, this means that he has selected the number five spot, with which to fuse the arrow spot, therefore 5 cm. is the patient's easiest fusion distance with o. u. + 10. Glasses correcting the refractive error should, of course, be worn and if there is much presbyopia, the o. u. + 10. should be made enough stronger to correct it. This will slightly increase the prismatic effect of the decentering.

Eyes are closed and the two rotary prisms swung into position to give o. u. 5^{Δ} base out. Patient opens his eyes and again states position of the arrow. If over six, the amount of prism which makes six centimeters the easiest fusion distance has been found. If not correct one or two trials will secure it. Should the arrow be seen between

six and seven, less than o. u. 5^{Δ} is required; should it be seen between five and six, more than o. u. 5^{Δ} is needed.

As all the eards, except series B, H and I, are 6 cm. between centers, the stereoscope is now approximately suited to this particular patient, and we, therefore, proceed to test his fusion faculty. Unless the case be one of anisometropia or amblyopia, it is well to begin with series F.

With F_1 the patient should see the vertieal line passing through the dot. If the line, whieh is seen by the left eye, is too far to the right, that is, heteronomous diplopia, the prism base out should be reduced until the direet alignment is secured. If the line be to the left of the dot, it is evident that the reverse is indieated.

By means of the card B_3 the exaet prism needed may be determined. Obviously it is the amount with whieh the patient sees the

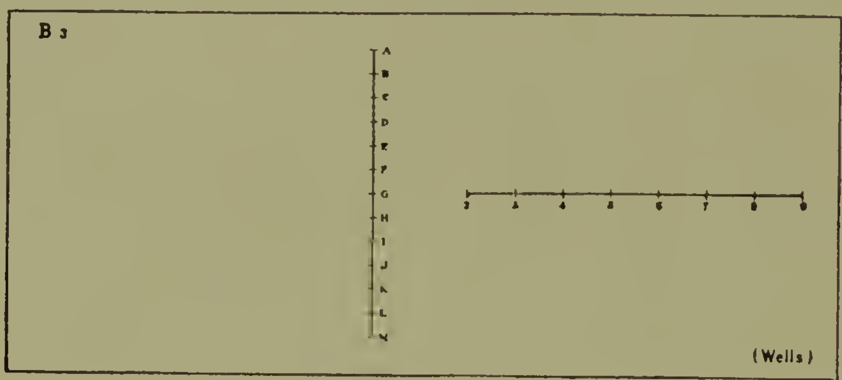


Fig. 23. Card B_3. To Measure Stereoscopic Hyperphoria. (Wells.) Perpendicular line should be printed in red.

lines interseet at six, but the eruder method with B_1 is preferable in the beginning.

B_3 is designed espeeially for the aecurate measurement of stereoseopic hyperophoria, whieh is often quite different from that shown by other tests. The divisions of the red vertical line are 5 mm. apart. If the blaek horizontal line is seen to cross the red vertieal line at H, 5^{Δ} right hyperphoria is exhibited.

Hyperphoria may interfere with fusion. It is then necessary to correct all or part of it with a vertical prism in the elip.

Patient's eyes are elosed (unless otherwise stated, it is to be assumed that the patient's eyes are always closed before each change) and succeeding numbers of F used in numerical order. It should be noted if either eye fails to see its respeetive lines and dots, and, if suppression occur, whether it be always of the same eye or of alternate, right and left. Let us suppose that, beginning with F_4, the left eye fails to see the line or dots belonging to the left picture, although the letters are eorrectly read.

The case should be recorded:

"Stereoscope + 10. = 5 cm., $\supset$ Pr. o. u. 5^{Δ} B out = 6 cm. Suppresses Left $F_{4, 5, 6, 7, 8}$."

This test might have been made with C_9 or series G, but it has been found that series F furnishes quicker and more reliable information.

Series E is devoted to perspective.

If with E_1, the antero-posterior relation of the dots is correctly stated, the subsequent numbers are tried in order. If E_5 is not correctly seen, to the record is added "E, o. k. to 4" or "Fails E_5."

Much attention is given to series E, both in the office treatment and the home exercises (mentioned later) to develop fusion with perspective, and one should not be satisfied until the whole series can be easily

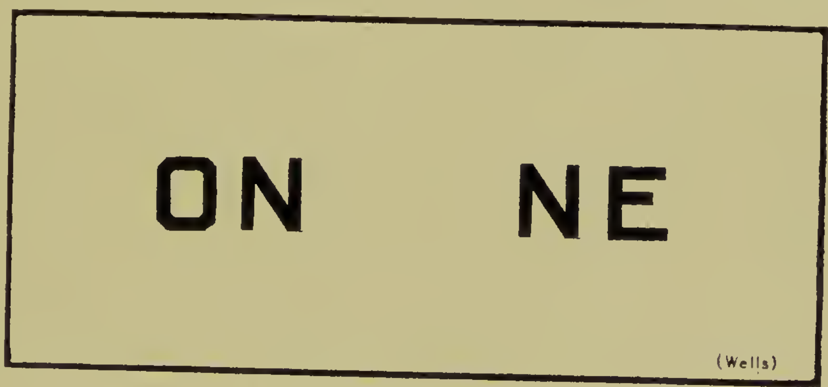


Fig. 24. Stereograph C_7. For Cultivating Stereoscopic Convergence. (Wells.)

perceived, not only when the stereoscope is adjusted for the easiest fusion distance, but also when the prisms are increased so that much convergence is required.

AMPLITUDE OF FUSION.

C_7 is now put in place, and as the N's are just six centimeters between centers, the two N's are perfectly fused and the patient reads "O N E."

Now while the patient watches the fused image, the p. d. of the spheres is increased by gradually turning the screw to the limit (75 mm. p. d.). The eyes are then closed and the p. d. of spheres is reduced to minimum (55 mm.). 5^{Δ} more, making 20^{Δ} in all, is now turned up in each prism. The patient will fuse this easily—but let us note just what has been accomplished. Assume p. d. = 60 mm., then he has fused 20^{Δ} less $5^{\Delta} = 15^{\Delta}$. As 10^{Δ} was required to bring the arrow over six on the B_1 card, 15^{Δ} less $10^{\Delta} = 5^{\Delta}$ = effort put forth. This

process is repeated, adding from 5^Δ to 10^Δ each time, until the "ONE" breaks apart before the spheres are fully separated. If this occurs, using o. u. Pr. 25^Δ, when spheres show 65 mm. p. d., record should read "amplitude 'ONE,' or $C_7 = 55^\Delta$."

It is extremely important at the outset to let the patient understand that you are giving him your undivided attention, and that the same is demanded of him. It is better to allow no third person in the room, not even the assistant or secretary. The statement that this is really a test of one's will power, will put the patient on his mettle.

Much can be learned by watching the patient's eyes over the top of the phoro-optometer. Usually they both converge equally, but occasionally one eye will participate but little, and this will be the eye which is suppressed in the finer tests of fusion faculty. The treatment of this condition will be taken up later, but it is here noted to emphasize the importance of observing all the conditions.

In this particular, this form of stereoscope overcomes a serious objection to the amblyoscope, because with the latter the eyes cannot be watched, and we must depend on the patient's statements, which are naturally very unreliable, especially when treating children.

But to return to our case:

The limit of fusion would be anywhere from 20^Δ to 50^Δ on this first trial. Phoro-optometer is then removed and loose prisms held before the eyes, base out, and strength increased until the limit for fusing a distant light is reached. The exercise should be stopped as soon as any fatigue is evident and pneumo-massage, fine Faradic electricity or high frequency given. The pneumo-massage is quite agreeable to the patient. For some years high frequency vacuum tubes have been used, 50 milliamperes for five minutes. It may be that all this has no further importance than the soothing and suggestive effect.

This whole treatment requires 15 to 25 minutes, and is given three times a week for three weeks, or until sufficient power has been attained. Most patients gain rapidly, but some show little improvement after half a dozen visits. After the 60^Δ of the two rotary prisms has been fused, round prisms from the trial case are inserted in the clips. It is practicable to use as high as 10^Δ before the right eye and 20^Δ before the left. This furnishes 90^Δ in all without any decentering.

Just what constitutes sufficient power is not a fixed amount for all cases. Successful ones average 80^Δ to 90^Δ with the phoro-optometer stereoscope, and 50^Δ to 60^Δ loose prisms. Many, especially the younger, will develop an amplitude of over 100^Δ, both with stereoscope and loose prisms. When sufficient power has been gained, the time between treatments is gradually lengthened to two a week, one a week,

one in two weeks, etc., provided the maximum reached at the previous visit is still attainable.

It may be well to try the holding power of other cards, especially the L. F. the fusion of which makes E, but it is believed that the ONE gives the greatest mental stimulus, as one's sense of proportion is disturbed at seeing the letters break apart.

The treatment of muscle defects is sometimes varied by what the writer calls the *recovery exercise.* With C_7 a few trials at decentering are made, the eyes allowed to close when the fusion limit is reached, and then the patient is told that this time his eyes are to remain open, that he must speak the instant he feels that he is about to lose his fused image, and that the prisms will be turned to help him get it clear again. It requires several trials before he can overcome the tendency to close the eyes, and then the prisms will need to be reduced very much before he will say "all right, I have it now."

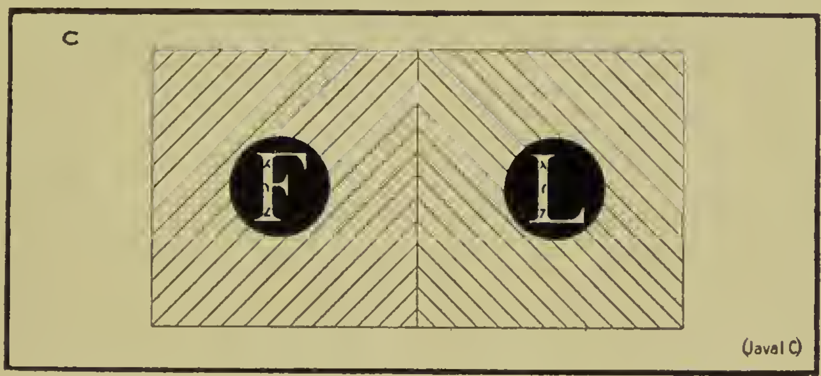


Fig. 25. Stereographic Card Number C_8. (Wells.)

After six or eight trials the recovery will be very much quicker and will require only a slight reduction of the prism. It is believed that this exercise has considerable practical value in teaching the patient to overcome the slight turning tendencies, which may annoy him in reading.

Home exercises with the stereoscope. The patient is required to obtain a Holmes stereoscope with clips for inserting extra prisms, and a set of the Wells' stereoscopic charts. It is important that the patient own these, as he is expected to use them occasionally for some months, to insure his retaining his newly acquired faculty. These charts are not to be used indiscriminately, but in accordance with very exact instructions.

If at the first examination the case showed a fair degree of fusion faculty, seeing half the cards in series F, G, and E, he is given F and G to use in numerical order, stopping when a few seconds fail to

secure perfect fusion of the letters. This exercise requires ten to fifteen minutes and should be done three times a day.

After the second visit, series E may be added to home work with instructions to run rapidly through F and G. When these cards, which are 6 cm. between centers, are mastered fairly (not necessarily perfectly), series H and I are to be used in the following manner: Patient inserts B_1, notes position of arrow and selects the same number of series H or I to begin with. For example, if with B_1 arrow is seen over six, H_6 is the first to be used. This will be fused with ease, as it is the distance between centers to which patient and stereoscope are adjusted. The order is now toward the smaller number, 5½, 5, 4½, etc., as it is convergence amplitude which is needed. When the

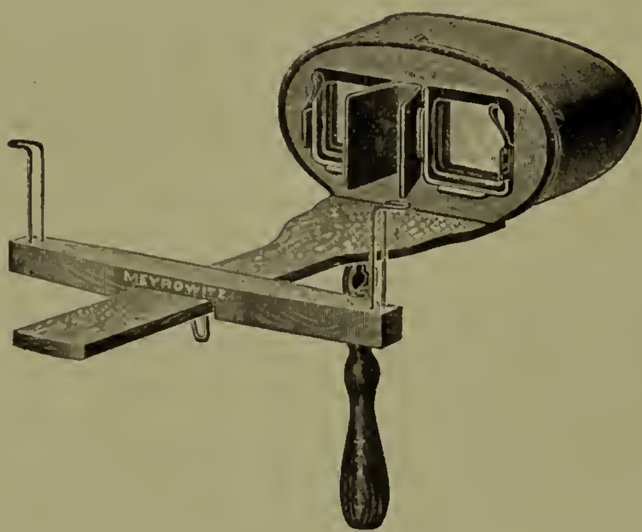


Fig. 26. Holmes' Stereoscope with Clips for Extra Prisms.

narrowest of these cards can be easily fused, a pair of 5^{Δ} prisms is inserted in the clips, bases out, and the same exercise repeated. In many cases a pair of 10^{Δ} prisms is used.

This use of H and I must be explained to the patient with great care and he is given a card with the following printed instructions: "Take card marked B_1. Notice the number of the disc over which the arrow is seen. Select same number of series H and I and work down to smaller numbers." On the same card the directions for all the home work are written; for example: "Series F, G, H and I, 10 to 15 minutes, three times a day."

In the average case ten to twelve treatments suffice to put the patient on an independent basis; that is, he has learned the knack, appreciates the relief of perfect fusion, and knows how to send the required neuricity to the internal recti.

For further refinement of fusion, George A. Shepard, of New York, has devised some very ingenious exercises in fusing colors. His instructions are as follows:

"Series D is designed to be used in those cases in which the muscular power is good, but the patient's ability to blend the images of the two eyes into a satisfactory binocular impression is deficient.

"As the fusion function consists of a subconscious control of the visual lines, it is essential that the activity of the psychic center be strongly stimulated. In order to do this, cases must be individualized and such cards be presented as will best catch the attention and tickle the imagination. While it is still a moot point as to whether the perception of color is to be placed in the sphere of physiology or psychology, there can be no question that the blending of two monocular complementary colors into a neutral tint must be purely psychic. Where objects of the same form are to be fused, or where the separate images are incomplete, a desire for symmetry in the one and a striving to satisfy a memory picture in the other serve as strong incentives to fusion. Hence, it is necessary, in a certain proportion of cases, to eliminate these factors if perfect self-reliance is to be established.

"The D series has retained the same form and size of figure for the two eyes to aid the patient in properly adjusting the visual lines so the colored rectangles shall fall upon the corresponding retinal areas, but the neutralization of the colors demands that proper values be given to each impression. This series cannot be used to advantage if the patient has congenitally defective color sense or is suffering from nonconcentric contraction of the color field, such as often occurs in neurasthenia.

"The exercise can be made still more exacting by having the form of the colors dissimilar and eliminating the control gray tint, but this would require the constant personal attention of the observer and make the charts less useful for home work."

Cross's stereoscope for home exercises. Cross, of Worcester, Mass., has devised a cylinder with 14 facets, on which he has pasted the 13 cards of series H and B_1. This is mounted on the Holmes stereoscope, arranged with a ratchet, so that the patient can turn up one after the other of the cards, progressing in either direction. Since it is wiser to have a period of relaxation between the repeated efforts of convergence, Cross suggests that the patient's eyes should be closed while the cylinder is being revolved.

Many years ago Landolt suggested the use of the ordinary stereoscopic pictures, putting *two dots on one picture and a third dot on the other*, so that the three will appear in a vertical line in the fused image.

For homework after the patient has ceased his regular visits, two or three dozen of such photos, selected by him, are marked in this way, the dots being made as small as possible. He is thus taught to appreciate the absolute reproduction of natural scenery, and is constantly able to verify his binocular perception by a glance at the dots. These cards are used with the 5^Δ or 10^Δ prisms in the clips and thus combine fusion and convergence training.

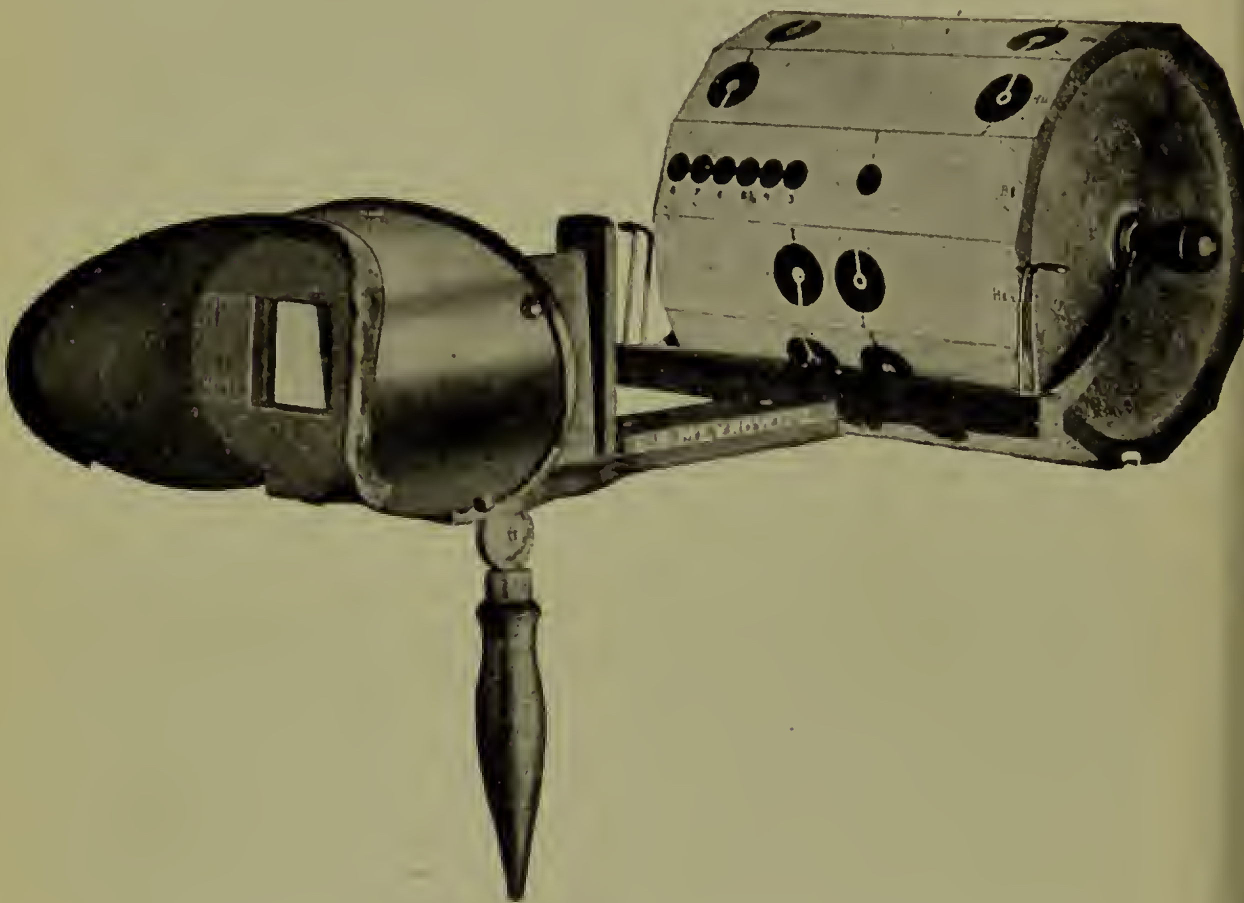


Fig. 27. The Cross Stereoscopic Attachment for Home Exercising.

It is advisable to insist upon good photographs properly mounted. The Underwood & Underwood Company, of New York, offer a fine selection of views from all parts of the world. They have recently published a set of photographs devoted entirely to perspective, with sufficient instruction on the back of each card so that the patient can assure himself that he is seeing it stereoscopically.

Stereoscopic treatment of esophoria. The proper treatment of esophoria necessitates a careful estimation of all the factors concerned. One is not justified in concluding that the convergence faculty is too

strong. Esophoria at distance is often associated with exophoria at near. In these cases duction will be found quite limited.

Paradoxical as it may seem, the writer is convinced that esophoria at a distance is not infrequently an expression of convergence insufficiency. Just how this is brought about he has no very definite opinion, but as the convergence function is the one most directly under the control of the will, it is conceivable that it might be exercised "not wisely, but too well," in a vain effort to overcome some annoying exophoria or hyperphoria.

Esophoria, dependent upon latent hyperopia, is quite common, and there is a general opinion as to what this association implies. The constant need of innervation of the ciliary for distance, as well as near, in some way causes an over-stimulus of the associated conver-

Fig. 28. Showing Dots Marked on Stereograph. (Landolt.)

gence—the coördination is disturbed. The full correction of the whole refractive error under atropin is, therefore, the first requirement and usually gives relief, but many of these cases show no reduction of the esophoria, the symptoms persist and the blurring of distant objects is quite annoying. For these cases and those not hyperopic, what shall be done? The use of prisms base out frequently "begets the calamitous necessity of keeping on." With each increase of prism more esophoria develops, until one may be forced to do a tenotomy or advancement to give his patient relief.

The stereoscopic treatment consists first of a thorough testing of the fusion faculty, and if any defect be found, the use of controlled reading device and the stereoscopic charts which cultivate a refinement of fusion, like F, G, D, E. To this point the treatment may be identical with that given for exophoria.

In using the phoro-optometer stereoscope, the patient should learn to fuse with prism base in, if we are to secure a greater divergence power. The same o. u. +10. are used in the frame, and card B_1 determines the easiest fusion distance by the position of the arrow. Let us suppose it to be seen over three, this means that the two discs 3 cm. apart are the easiest fusion distance.

Rotary prisms 15^Δ each base out ought theoretically to bring the arrow over 6. C_7 ON NE is then introduced and the spheres approximated so as to reduce the base out of the rotary prisms. When the limit has been reached, the patient's eyes are closed and the lenses separated as far as possible, and the base out of the rotaries reduced 5^Δ, leaving 10^Δ each.

If the patient's pupillary distance be 60 mm. and the phoro-optometer show 70 mm. p. d., 15^Δ each base out will be exhibited in this wide position and this will be as easily fused as at first. Now if the spheres be approximated while the patient holds the letter fused, when p. d. 60 has been reached, the prismatic element of the decentering has been eliminated, and the amount as shown by the revolving prisms, 10^Δ each, is the total. If the approximation be continued to 50 p. d., then the 5^Δ each base in produced by the decentering reduces the base out of the revolving prisms, and the patient has diverged from his first position and maintained fusion with o. u. 5^Δ base out.

The eyes are now closed again and the spheres separated as far as possible. Rotary prisms are now reduced 5^Δ each, so that the reading which was before 10^Δ is now 5^Δ. Patient opens his eyes and if he is able to fuse the ON NE, lenses are approximated as before. This process is repeated with smaller changes in amount of rotary prisms as it becomes evident that the patient's limit is being reached.

As was said before, the home use of the cards as far as series G is the same with all forms of heterophoria, because with all of these cards the distance between centers is 6 cm., and their use is for the cultivation of a refinement of the fusion faculty. For amplitude training it is evident that the progression in the use of series H and series I must be the reverse of that for exophoria; that is, if the patient sees the arrow over 4 with B_1 card he should commence with H_4 or I_4 and work up to higher numbers, 5, 6, 7, etc.

In many cases where there has been present esophoria for distance and exophoria for near, the convergence duction has been found so poorly developed that the writer has treated the case the same as for exophoria, both with the phoro-optometer stereoscope and the homework for cultivating amplitude.

Increased convergence has relieved the symptoms and has not increased the esophoria. In some instances orthophoria has been restored. It is experiences like these which have forced the conclusion that there exists a pseudo-esophoria, which should be interpreted as an insufficiency of convergence and not excess.

Stereoscopic treatment of esotropia. Since Worth's first publication in the *Lancet,* May 11, 1901, the writer has been a conscientious follower of his methods.

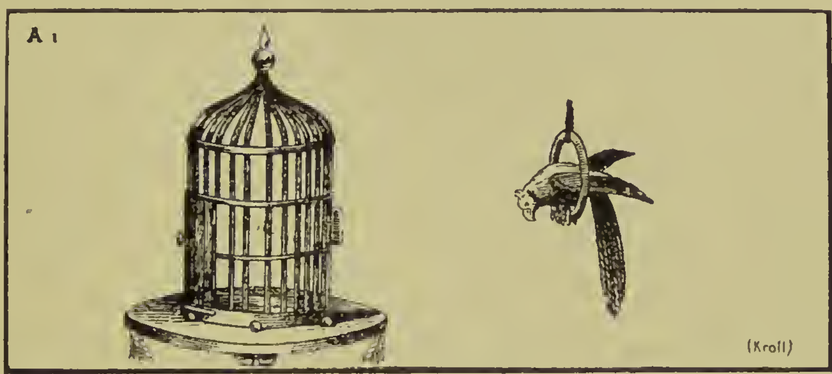


Fig. 29. Card No. A_1. For Left Esotropia.

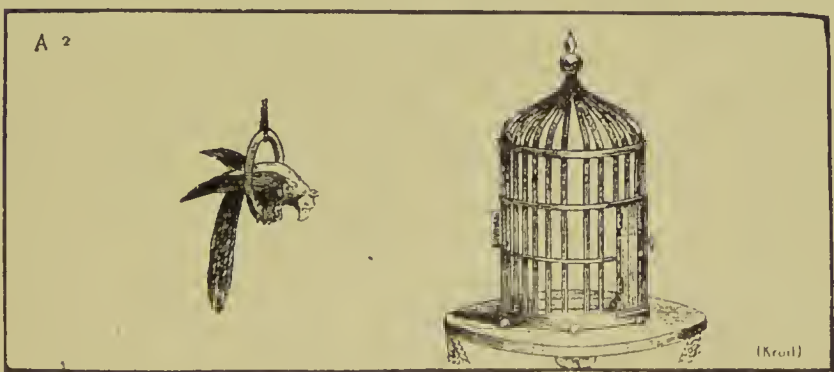


Fig. 30. Stereoscopic Card, No. A_2. For Right Esotropia.

A certain number of cases of concomitant esotropia can be cured by monocular atropinization and the use of the amblyoscope, but this latter instrument has been rather disappointing. There are definite drawbacks to its practicability. In the first place, one cannot see the child's eyes and is, therefore, forced to depend on his statement as to what he sees. The imagination of the child is very vivid and no one who has tried to carry out this treatment can have failed to be at his "wit's end" many times to know just what was taking place.

Then it is absolutely essential that the case be seen early and that the parents' intelligent co-operation be secured.

When the child is able to comprehend the Worth amblyoscope, it is ordered (with the simplest pictures) for home use, and the phoro-optometer stereoscope used at the office. Fusion can often be secured with the latter in a case needing in each eye a prism 30^Δ base out. Here we make use of A_1 for left esotropia—A_2 for right esotropia.

Not until concrete pictures like C_1, C_2, C_3 can be fused need one expect much from stereoscopic exercises.

There is very little holding power in discrete pictures, either with the stereoscope or amblyoscope,—the bird out of the cage makes just as pleasing a picture as the bird in the cage, but when the head of C_2 loses an eye or an ear, one's sense of propriety is offended.

The prismatic element can be reduced by decentering, the same as in treating esophoria, and the eyes may be watched all the time over the top of the instrument to note their movements. It is possible to watch the child's eyes when using a Holmes stereoscope by cutting away the top of the hood (Fig. 31). This arrangement is important when testing for malingering and will be referred to later.

In a favorable case the home stereoscope with as high as 15^Δ base out before each eye can be used, the amount being reduced as conditions warrant.

It is somewhat difficult to state exactly the percentage of cures that may be expected by orthoptic treatment alone. It is almost impossible to carry out the full treatment with dispensary patients.

Of all the private cases of esotropia seen by the writer during the last five years, only twenty-five per cent. were less than six years old. Some of these moved away and were referred to colleagues in other cities. Others gave up the treatment after a few visits.

Excluding the congenital cases, nine per cent. were given the recognized orthoptic treatment, and of these nearly three-quarters were cured and developed a fair degree of binocular vision. A few cases, averaging thirteen years of age, responded to glasses and fusion-training methods. Most of the other cases were corrected by advancement of one or both externi. Post-operative fusion training has been used in all except those lacking all fusion sense.

Since only twenty-five per cent. were less than six years old, it is evident that it is still necessary to emphasize the importance of beginning this treatment early.

The intelligent co-operation of the family physician means that he

shall refer every case to his ophthalmic surgeon, whenever there is discovered even an occasional squint. It is true that the wearing of glasses under two years is attended with some difficulty, but many other expedients can be used to force the seeing with the turned eye. These may be atropin in the fixing eye and an occlusion bandage. The object of this very early treatment is to preserve the turned eye

Fig. 31. Stereoscope Hood Cut Away to Facilitate Watching the Eyes. (Wells.)

from amblyopia exanopsia, and to cultivate the fusion faculty during those years when it is developing in the normal child.

This treatment should be continued as long as the deviometer shows improvement. This may be months or years, but it is certainly a mistake to delay operation too long. A rudiment of fusion can often be trained into a refined faculty if the eyes are put approximately straight by operation. This may be as early as five or six years of

age, provided the operation be an advancement without a tenotomy.

The stereoscope in alternating esotropia. In these cases vision is usually equal in the two eyes, and there is very little refractive error. A cycloplegic, or even a slight blurring of either eye, causes it to converge and the other eye to fix. Fusion faculty is usually nil, and any sort of orthoptic treatment generally of little use. Advancement of both external recti is usually required.

The stereoscope in exotropia. If occasional, stereoscopic treatment and fusion training will usually cure the exotropia; the method being the same as for exophoria. The result is often orthophoria by phorometer, Maddox rod or chromatic test, but exophoria may be still shown by the screen test. As the normal condition of the individual is with both eyes participating, it seems appropriate to use a binocular test, especially the chromatic, in which the tendency to horizontalize and verticalize is reduced to a minimum. This also shows the value of the fusion faculty in maintaining orthophoria. If the exotropia exists all the time immediate advancement of the internal rectus, followed by stereoscopic training, is indicated.

The stereoscope in the post operative training of strabismus. Landolt (*Trans. Ophthal. Soc. U. K.*, Vol. XXXI, 1911) states that: "Immediately after the definite removal of the dressing, exercise for binocular vision must be begun. The patient operated upon for convergent strabismus will wear spectacles to correct the total hypermetropia and astigmatism, if it be present. The one who has been operated upon for divergent strabismus will be allowed, and even urged, to look at objects at close quarters, for the purpose of exercising his convergence. All patients should go through exercises intended, firstly, to perceive simultaneously the visual impressions of both eyes, then to combine the true impressions so as to give rise to the sensation of the third dimension."

While it is perfectly true that a majority of the previously strabismic eyes are extremely amblyopic, nevertheless to rest content with a cosmetic success, without attempting to cultivate binocular vision, is not discharging one's whole duty to one's patient. Even though the vision of one eye is quite defective, there may be developed a degree of fusion which is not only quite useful to the patient but is the best possible prevention of a recurrence of the heterotropia. Some with vision as low as .2 can be taught to appreciate relief, a true binocular single vision.

If a true antipathy to fusion exists, it is useless to persist. It is quite possible that such cases are due to a complete, instead of partial, decussation at the chiasm—a reversal to an ancestral type. Worth

thinks the alternating cases fall into this category; but the rule is not invariable.

If the vision of both eyes is good, the change from heterotropia to heterophoria may induce all the symptoms of incoördination by the increased difficulty of suppression of one image. When one considers the complexity of the co-ordination required for binocular single vision, it is hardly conceivable that a surgical operation could change a heterotropia to orthophoria.

Illustrative case, No. 11819, April 4, 1916. Patient a lady æt. 28, with symptoms of headache, feeling of strain in the head and neck for fifteen years; at present not able to read ten minutes without great discomfort.

From her former oculist the following history was obtained:

"Mrs. X's condition Feb. 24, 1915, was as follows:

R. V. 6/5 Cycloplegic: R. V. 6/6, with + .25 D. S. $\supset$ + .25D Cyl. 90° = V 6/4.

L. V. 6/6 Cycloplegic: R. V. 6/10, with + .62 D. S. $\supset$ + .50D Cyl. 90° = V 6/4.

16$^{\Delta}$ exophoria distance, 20$^{\Delta}$ exophoria near. 3$^{\Delta}$ right hypophoria. A full correction was ordered for constant use, and various orthopic exercises tried, with no benefit to the heterophoria, and on April 20th I performed a Worth's advancement on the left internus with perfect immediate result. The exophoria gradually recurred, however, with the same intense asthenopia as before, and a complete tenotomy of the left externus was performed June 26th to correct an exophoria of 18$^{\Delta}$. This gave relief for about a month, when the symptoms began to recur. She was then given 5$^{\Delta}$ prisms over each internus, with 2$^{\Delta}$ prism base up right.

Mrs. X has been a puzzling case and I have come to the conclusion that her trouble lies in deficient fusion impulse. On more than one occasion since the second operation there was lateral orthophoria with the Maddox rod-test, for a minute, the visual axes then gradually diverging until 10$^{\Delta}$ or 12$^{\Delta}$ prisms were necessary to fuse the images. There was a strong neurotic element, and she suffered inordinately both at the operation and afterwards."

Examination:

Exophoria 10$^{\Delta}$ Prentice-Williams color phorometer.
Left Hyperphoria 2$^{\Delta}$ Prentice-Williams color phorometer.
Adduction 16$^{\Delta}$, Abduction 16$^{\Delta}$.

Binocular vision tests:

Stereo + 10 = 65 mm., Suppress L F_4, E_1 O.K.
"ONE" 30^Δ fuse 15^Δ, 2^Δ L Hyperphoria with B_8.

Since hyperphoria often disappears as the convergence increases, all prisms were omitted.

Treatment:

For home work with stereoscope series C, F & G were used at first and patient came to office three times a week. After six visits she was given control device and told to begin reading a few minutes at a time. At this time the stereo-convergence with C_7 ON NE was only 40^Δ, showing slow progress. In fusing loose prisms the left eye would diverge without patient recognizing the diplopia, showing the importance of stereoscopic duction. At the eleventh visit orthophoria by binocular tests, but exophoria 9^Δ by cover test. Left hyperphoria $2\frac{1}{2}^\Delta$, same as before treatment.

Stereo-convergence 90^Δ with C_7, loose prisms not tried, as the tendency to let one eye diverge was not cured. Could fuse H & I series with o. u. Pr. 5^Δ B out in stereoscope. As the hyperphoria persisted prism $1\frac{1}{2}^\Delta$ base down was added to left.

April 22nd, *i. e.,* two weeks after beginning treatment, "no pain in eyes, has read one-half an hour at a time." April 29th, "has used eyes most all day, doing exercises, reading and sewing."

As patient lived in a distant city, she was allowed to go home, but she was given very definite homework. The control device was changed from the single to the three prong, the 5^Δ prisms were increased to 10^Δ, and exercises varied by the use of a couple of dozen marked stereographs. Not seen again until September 6 (four months), when she reported that she could read two or three hours with the three prong control, and sew and write as long as she wanted to with the one prong control. Exercises had been kept up but at increasing intervals. Orthophoria by binocular tests; exophoria 10^Δ by cover test. Stereoscopic convergence 90^Δ with C_7.

From the above case it is evident that post-operative training is carried out in the same manner as the pre-operative. If controlled reading is possible, the constant use of the device for *all* near work is most valuable. This should be continued for many months, possibly a year.

Difficulties in the use of the stereoscope. It was stated that successful cases of orthoptic training average ten to twelve treatments. Just when one should give up and call the case a failure is a matter of individualization. One patient, who had made practically no progress in eleven treatments, at the twelfth visit seemed to "catch

on,'' showing the cumulative effect of the previous effort, and in four more sittings fused over 100$^{\Delta}$ both with the stereoscope and loose prisms, with complete relief of symptoms. When seen again after six months there had been no loss of power.

If, as one watches the eyes over the stereoscope, and this should always be done, one eye is seen to turn but little, the prism before the other eye is turned to zero and the whole amount exhibited before this ''lazy'' one. This has never failed to stimulate the convergence. This will always be the eye which is suppressed in the test with series F and G.

Theoretically the accommodation should be at rest, and this is accomplished when the emmetropic eye looks through a +10. at a chart 10 cm. distant, but with a case which fails to converge when the spheres are separated, it is justifiable to utilize the accommodation to start the habit. This is done by substituting +7. or +8. spheres.

The psychic element in fusion training. A highly developed fusion faculty, with good amplitude, is the ideal concomitant of perfectly corrected refraction. In correcting or relieving heterophoria, the first essential is the development of a refined fusion sense, if such does not exist, or in making habitual its employment in the psychic interpretation of two retinal images.

The power of a muscle depends not alone on its own physical properties, such as size, nutrition, place of attachment, etc., but also on the strength of the nervous stimulus which excites its action. In discussing this subject, in 1902, the writer made the following statement: ''The rapid development of adduction, which is so often obtained by this so-called 'gymnastics,' strongly suggests that the gain is not a muscle hypertrophy, but an increase in innervation, either in the responsiveness of the end organ in the muscle, or the convergence center, or both.'' In the educational treatment of tables the incoördination is overcome by teaching the patient to gauge his motor impulses by the eye, in lieu of the normal sensory control. Repeated artificial contractions of the internal rectus (the ciliary remaining relaxed) establish a habit of increased action, so that it no longer lags when the impulse to converge and accommodate is felt. The co-ordinating center may also be taught to better appreciate the advantages of binocular perspective. This is no special pleading, but is analogous to other sensations. The pianist makes his fingers educate his brain, that the brain may do better work with the fingers Tasks consciously performed are in time relegated to subconscious control. If this interpretation of muscle gymnastics be accepted, it is evident that the first indication is to teach the patient the fas-

cination of true binocular fusion. Just as in the ordinary prism exercises, with the eye fixed on a distant point, the aversion to diplopia is an incentive to increased muscle action, so here the fused image becomes an anchor. With the eyes fastened on a fused image, made up of half pictures, one strongly resists an impulse which tends to pull it to pieces. The decentering of plus 10. lenses is a subtle means of insinuating such an influence.

In all exercises of this sort there is a psychic factor which should be utilized. Whether there is or is not a fusion center, there is a fusion faculty which can be cultivated, in proportion to the patient's attention and coöperation.

To do this, while the phoro-optometer stereoscope is being used, the patient should be repeatedly directed to fix his attention on the red N of the "ONE" card. To help him do this he should be told to analyze the color, to decide just what shade of red it is, or to fix his attention on the oblique line of the N. Other expedients will suggest themselves if the importance of this fixation of attention is appreciated. No distracting sounds should be tolerated; in fact, there should be no third party in the room.

The patient should also be aware that the oculist is thinking only of him, and whenever any gain, however slight, is evident, as one watches the eyes over the stereoscope, some word of commendation should be volunteered. If no such commendation should be justified, he should be encouraged by the suggestion, "Now try a little harder this time."

The choice of cards in orthoptic training. The difference in the "holding" power of different cards has been mentioned. Formerly C_8 of Javal was used. This consists of separate letters L and F, the fusion of which gives E. After considerable experimenting the author devised the ON NE, the two N's printed in red, and believes this possesses the greatest holding power of anything yet produced. In the first place the word spells O N E, and when disjointed the ON NE is meaningless. More letters are superfluous and detract from fixation. That there is a subtle suggestion in this, one can easily verify in the following way: After the card ON NE has been used on several occasions, if the prism is arranged so the patient sees the arrow over 6 of the card B_1, and if then C_7 is dropped into the clip, the patient will often be confused, but will be immediately relieved if 5^Δ or 10^Δ more of prism be turned up. This shows that while conditions were exactly right for easy fusion of C_7, the instant that card appeared he immediately remembered what it had previously required and involuntarily converged his eyes more than was necessary.

It is advisable to experiment with other cards, especially if the case is not progressing well.

Fusion amplitude in using the stereoscope. In convergence insufficiency we are dealing with an incoördination of convergence and accommodation. The nerve impulse sufficient to secure accommodation is insufficient for convergence. To relieve this and to restore co-ordination, it is necessary to incite, associate and to make habitual a greater degree of convergence with a given amount of accommodation. For this reason it has always seemed to the writer that exercises which bring into play the accommodation as well as the convergence are illogical; e. g., dot exercises at the reading distance, or the candle as used by Gould.

With the eyes fixed on a distant light, it is assumed the accommodation is zero, but this is difficult to verify. When emmetropic eyes looking through plus 10. lenses see clearly at the focal distance, 10 cm., we have proof that the accommodation is relaxed, and it is under these conditions that we secure a very abnormal amount of convergence. To a certain extent the same is true of the home use of the stereoscope with additional prisms in the clips.

With perhaps one-half of one's successful cases orthophoria will be secured, with the other half the heterophoria will be reduced, but the patient will have secured such a superabundance of amplitude that he is able to overcome the wrong tendencies automatically without discomfort.

Not infrequently one sees a patient who has learned to overcome strong prisms who is still uncomfortable, because his fusion faculty is poor and co-ordination for small objects, like types, inexact. One can understand that a man might be able to make a long jump and yet not able to land on an exact spot less than his full distance. This ability to land exactly is what perfect co-ordination requires. The stereoscopic training of convergence accomplishes just this exactness. Stereoscopic convergence reproduces the conditions required for perfect binocular single vision. Finally, this is best stimulated by the decentration of spherical lenses.

STEREOSCOPIC OPHTHALMOSCOPY.

While it is possible with the binocular attachment to the Gullstrand ophthalmoscope (Bausch & Lomb, *Scientific and Technical Publications,* p. 111, No. 4) to get a true depth picture of the fundus, it requires such a nicety of adjustment and such intelligent co-operation on the part of the patient that its practicability is limited.

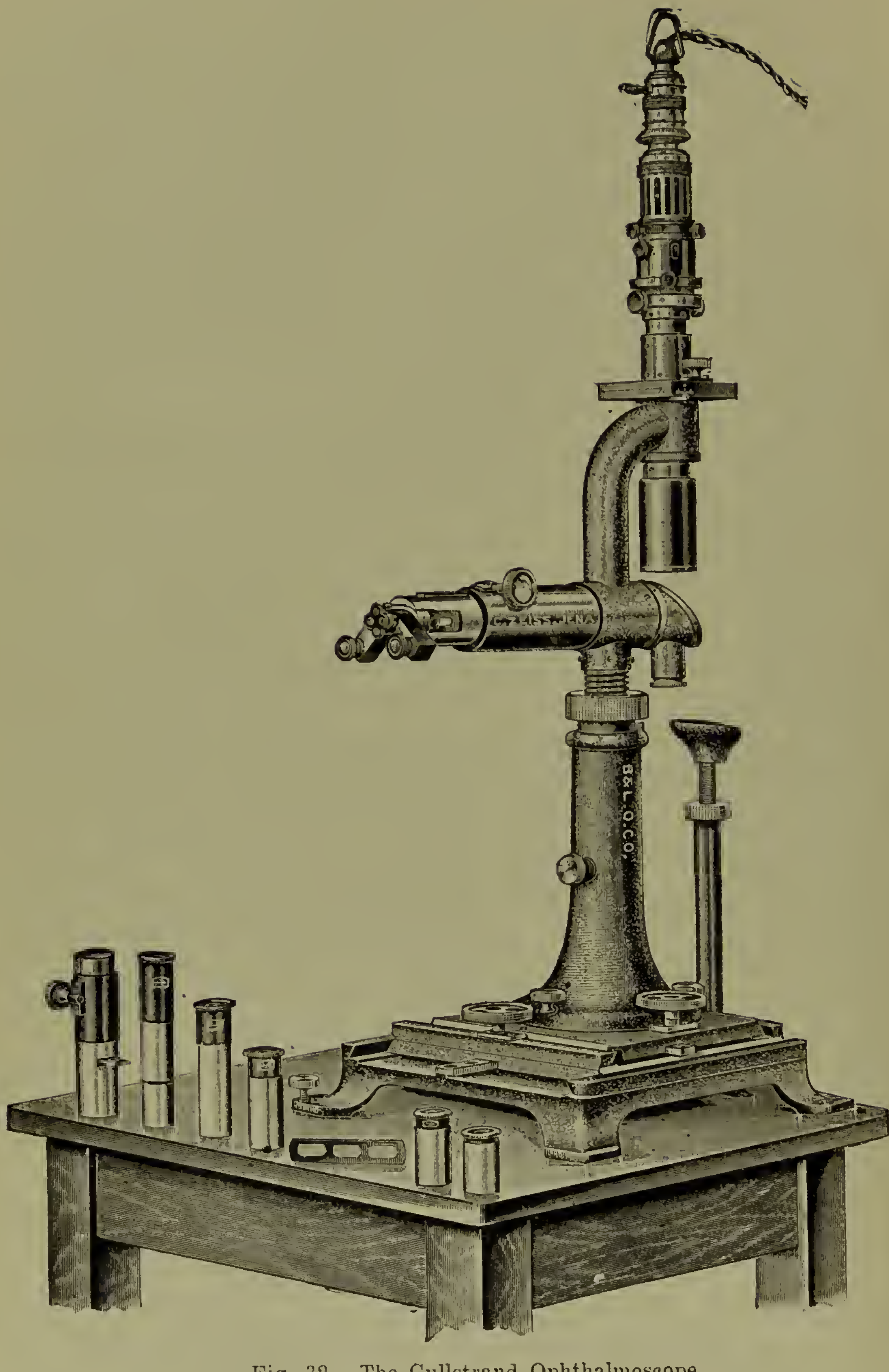


Fig. 32. The Gullstrand Ophthalmoscope.

Moreover the cost of the instrument ($500) places it beyond the reach of the great majority.

Previous to the invention of this apparatus Oatman published an extensive series of stereoscopic pictures of pathological fundus conditions which give a remarkable hemispheric effect. The method of making these the publishers refuse to divulge.

However, the general principle upon which they were constructed is easily determined by measuring corresponding points. The outer circles which bound the views are 77.1 mm. between centers; the optic discs are 79.7 mm. between centers. The disc requiring less convergence to fuse seems farther off than the equator which requires most convergence. The disc ends of identical vessels are farther apart than the equator ends. The effect is not always true to nature, the vessels at times seem to be in front of the retina as if detached, and the disc much behind the plane of the rim as if punched out. This is unavoidable as it is impossible to make elaborate drawings sufficiently accurate to meet the demands of stereoscopy. Until the fundus can be photographed stereoscopically such attempts will be unsatisfactory. The bizarre and distorted appearance of details more than offsets any possible advantage of the sense of sphericity.

THE STEREOSCOPE AS A DETECTOR OF MALINGERING.

The stereoscope is very useful in detecting malingering, especially with those patients who do not claim blindness in one eye, but impaired vision in one eye. Series G from Javal of the Wells selection is well adapted for this purpose. These can be read with one eye, but numerous dots and cross lines are alternately present on one side and wanting on the other, and unless the patient closes one eye he soon gets "rattled." Seeing depth with the perspective series proves binocular vision, but does not demonstrate acuity. With the phoro-optometer stereoscope or the Holmes model with the open hood (Fig. 31), the constant observation of the patient's eyes is possible and is essential as when used when testing heterophoria.

The phoro-optometer stereoscope is not claimed to be superior to stereoscopes devised for this special purpose, but the use of the same instrument which has been employed for holding lenses in vision-testing is less likely to excite suspicion than the introduction of another piece of apparatus.

Poullain's stereoscope. The detection of simulation seems to be the most useful field of Poullain's stereoscope. See Figure 33.

The special feature of this instrument is two discs concealed in front of the eyepieces. These discs are pierced with holes so arranged that when revolved by the arm E either eye may be occluded and the patient is thus unaware which eye he is using.

Fridenberg's stereoscope test for malingering. The instrument is simple, and affords a full view of the patient's eyes.

According to the catalogue description it was devised to reflect the image of a test card in such a way that it can be seen by only one

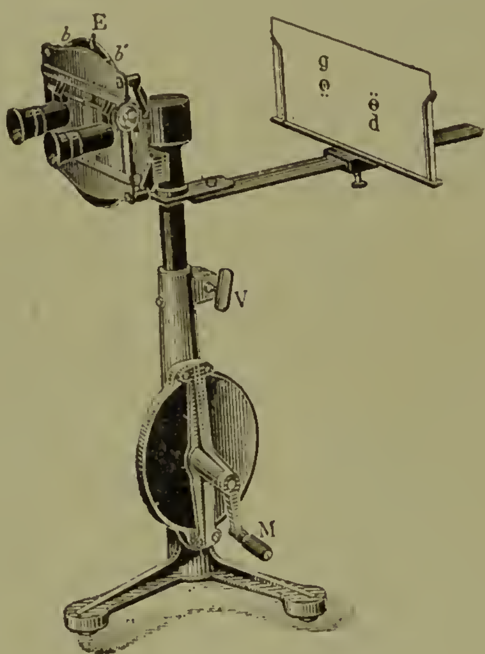


Fig. 33. Poullain's Stereoscope.

eye at a time, and a quantitative demonstration of vision made without the subject of examination obtaining any clue as to which eye is being tested.

The mirror is mounted on a horizontal arm in such a way as to permit of varying its distance from the test card, and of presenting it alternately to either eye by revolving the bearing through an arc of 180 degrees. The lateral tilt of the mirror can be changed at will, and is indicated by a pointer on a horizontal scale. When the pointer is at 90 degrees, the plane of the mirror is at right angles to the line of vision of the eye on the corresponding side, and this eye sees its own image. The test card on this side, however, is not normal to the mirror, and its reflection is seen only by the opposite eye, which the subject presumes to be unconcerned in the visual act, as it does not appear in the mirror.

By switching the mirror over to the opposite side of the arm, a similar double test can be applied, so that in all eight variations are rapidly obtained. The mirror can be adjusted laterally to correspond exactly with the interpupillary distance and correcting glasses inserted in the trial frame, if necessary.

"The test is simple, rapid and exact, gives no clue to the simulant, and can be demonstrated without theoretical explanations to the members of a commission or jury."

The adaptability of the Wells phoro-optometer stereoscope for the Haitz, Bissell and Lloyd charts. Before the appearance of the Haitz charts (see p. 5678, Vol. VIII of this *Encyclopedia*) the diagnosis and exact mapping of central and paracentral scotomata was very difficult and often impossible. A translation of the instructions for

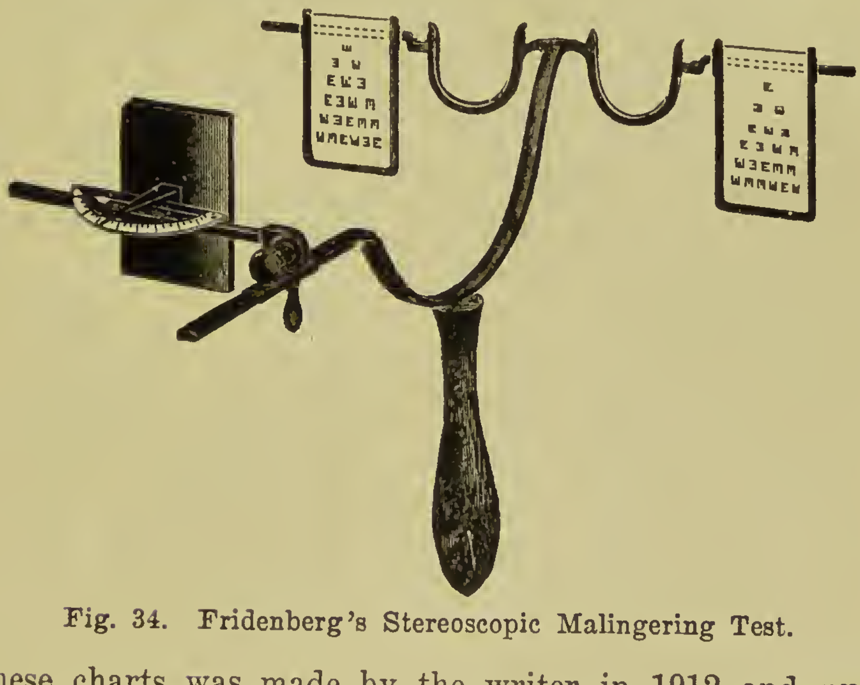


Fig. 34. Fridenberg's Stereoscopic Malingering Test.

using these charts was made by the writer in 1912 and published in the *Journ. of Ophthalm., Otol. and Laryngol.,* Dec. 1916.

These perimetric tests give an enlargement of the 10° circle, each square being the tangent of 1°, and secure exact fixation by utilizing the good eye provided the heterophoria be corrected. Even if the sight of the other eye is quite poor, it can maintain a fair fixation by fusing parts of the periphery of the octagon and lining up the dots.

In using these charts the writer at first followed Haitz' instructions, using an ordinary Holmes stereoscope, marking on the same the distance at which the chart should be viewed. It was soon found that holding the stereoscope was tiresome for the patient, and quite unsteady. As constant use is made of the phoro-optometer it was found much more satisfactory to use a stereoscope made to order for

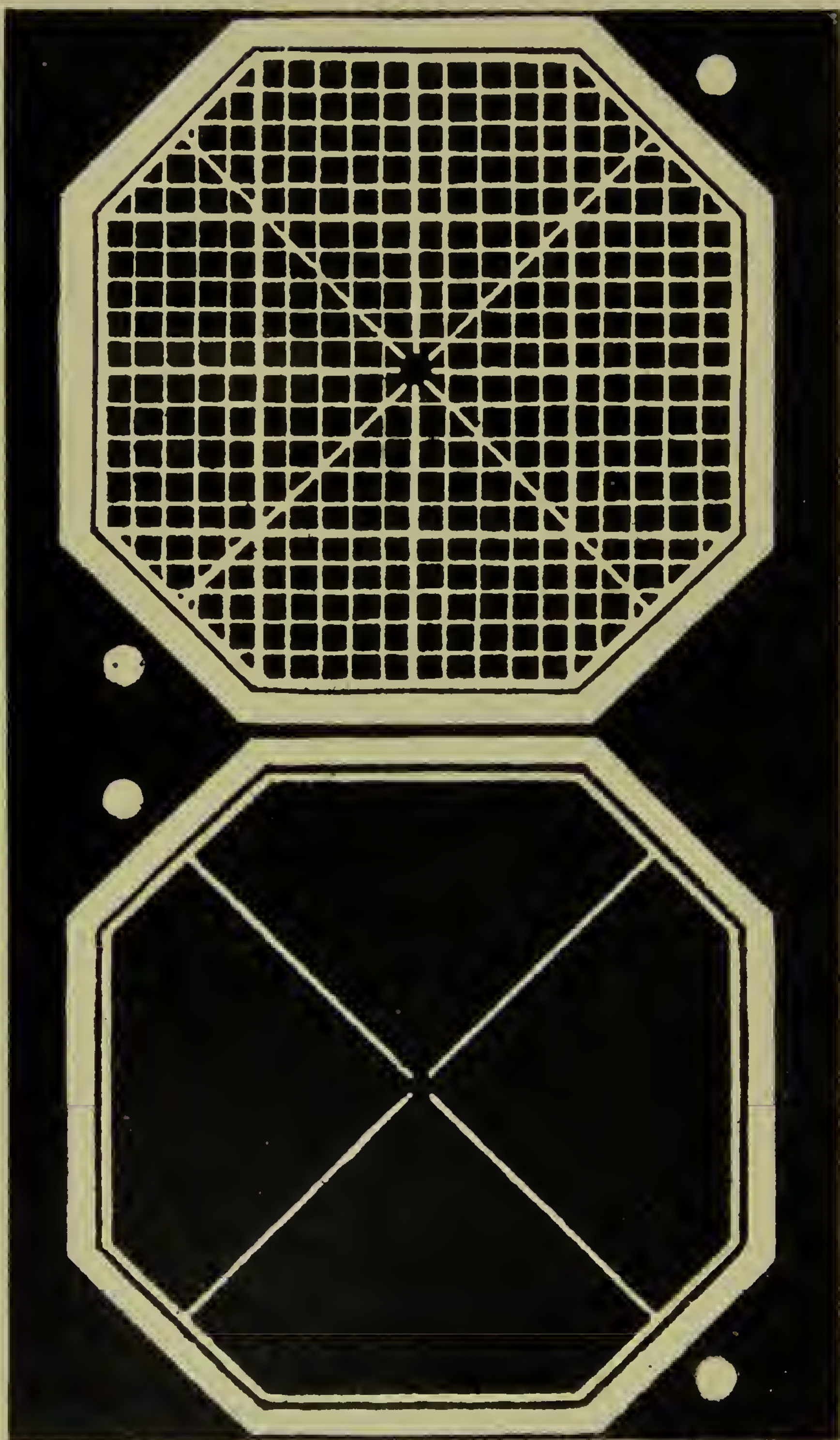


Fig. 35. Haitz Charts.

each patient; +5.25 toric lenses being employed with the chart at 17 cm. in front of them. In the ordinary use of the phoro-optometer stereoscope o. u. + 10. is employed with the cards at 10 cm. This makes each prism diopter ($^{\Delta}$) = deviation of 1 mm. With o. u. +5.00 at 20 cm., each prism diopter ($^{\Delta}$) = deviation of 2 mm. With the B_3 (Fig. 23) card the natural fusion of distance is determined, and sufficient prism introduced to make lines cross at 8, since Haitz charts have a separation of 8 cm. For example: should the red line cross at 5 this means that 5 cm. is the natural fusion distance. To secure the crossing at 8, fifteen diopters more is required, since 30 mm., more deviation is needed, and at 20 cm., each prism diopter = 2 mm., 30 ÷ 2 = 15. If the patient happens to converge, more prism will be needed, the exact amount being determined by turning the rotary prisms. The patient should wear his refractive correction unless the error be slight.

The modified stereoscope is ideal for mapping a central scotoma, and at the same time it has been demonstrated that the patient has binocular vision sufficient for the test. Since visual acuity is often poor and fusion faculty of low grade, it was found that the lines of the B3 card were too fine to be easily seen by many patients. A modification of B3 with heavier lines has, therefore, been drawn upon the back of the Haitz chart.

The Bissell blind spot chart. In 1916 Elmer J. Bissell published his chart for measuring the blind spot by the Haitz principle of stereoscopy. Great credit is due to Bissell for this suggestion, as it makes the blind spot measurement an exact procedure. The importance of this knowledge in incipient glaucoma and other affections is generally recognized. In using this chart, it is necessary to get a wider field. This is easily obtained by commencing with the o. u. +5.00 decentered out 5 to 10 mm. wider than the patient's interpupillary distance and substituting for the revolving prisms, after the necessary amount has been determined, plain prisms from the trial case. This increased distance of the lateral part of the chart changes the perfect correspondence of squares to degrees of the arc, but if one wishes to be more exact the chart can be bent by having a third support, so that the ends and the center will be the same distance away.

This defect has since been remedied so that the present Bissell blind-spot "Slate" has squares of varying size. At 5° from the point of fixation they measure 3.3 mm. and continue to increase gradually in size until at 25° they are 3.3 to 3.8 mm.

The Lloyd combination chart. This device, described in the *Oph-*

Fig. 36. Bissell Blind Spot Chart.

thalmic Record, August, 1917, is a combination of the Haitz and Bissell charts, and, therefore, suffices for both purposes. The color of the cross lines is much more subdued than the previous charts of American manufacture, and is, therefore, less confusing. If one is not fortunate enough to possess the original Haitz, he will find this a decided improvement even for central scotomata, while for the blind spot measurement it shows at a glance the relation to the macula, and the normal area according to Gradle.

The writer suggested to Bausch & Lomb the making of record slips duplicating the slate. These suffice for recording either central or para-central scotomata or blind-spot measurements, for one or both eyes, and always maintain the relative positions. One may mark on the slate with chalk, and transfer the record later, but it has been found quite satisfactory to have the assistant stand behind the patient —slip in hand—watching the point reached by the object, when the patient first sees or loses it, and mark it immediately on the slip.

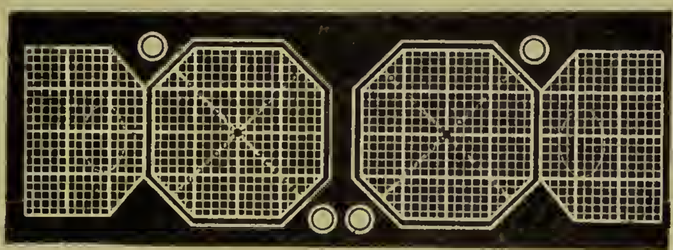


Fig. 37. The Lloyd Stereoscopic Slate.

In this way the permanent record is finished as soon as the test is completed.

Those who do not use the phoro-optometer will probably prefer to use the Bausch & Lomb wide-angle stereoscope, but the method described does not necessitate the patient's moving from his chair, dispenses with a new instrument, and gives one a knowledge of the patient's fusion faculty, *which should be investigated before attempting the test.* The only expense involved is the central aluminum screen, the cost of which is trifling. Moreover, the writer still lives in hopes that more of his colleagues will recognize the value of the phoro-optometer stereoscope in fusion training and the cultivation of adduction. This adaptability for either the Haitz, Bissell or Lloyd charts is an additional reason for the adoption of this instrument.

Wide-angle stereoscope. At the Pittsburgh meeting of the Academy of Ophthalmology and Oto-Laryngology, October, 1917, Bissell exhibited under his name an instrument which had been made at his suggestion and with his constant co-operation. In this communication he

gave detailed instructions for blind-spot measurement and suggested the usefulness of the instrument for stereoscopic field testing by increased range. This has been done by Lloyd, who reported a number of interesting fundus cases (Bausch & Lomb, *Perimetry and Campimetry*) with fields mapped out by the perimeter, the Peter campimeter and the wide-angle stereoscope, showing the superiority of the last named for accurate localization of scotomata and for the measurement of color fields.

Mr. Max Poser has furnished the following description of the instrument, but the writer thinks the change in name ill-advised since it seems to limit a valuable stereoscope to campimetry.

"We have agreed on the name Stereo-campimeter instead of wide-angle stereoscope since various prominent ophthalmologists considered this name more appropriate.

"The historical record of this instrument is: Dr. Bissell asked the writer to construct a stereoscope by means of which he could use a special chart designed by him and which is the present 'Bissell blind-spot slate.' Shortly afterwards Dr. Ralph I. Lloyd, of New York, and Dr. Gilbert Palen, of Philadelphia, also desired to have an apparatus of this kind and the writer set to work and constructed a wooden model, making use of lenses corrected for a wide angle, free from astigmatism of oblique pencils with the result that even a larger angle was obtained than desired by the above mentioned gentlemen, at first.

"Dr. Ralph I. Lloyd, realizing the advantage of the extra large field obtainable, designed the present Lloyd slate (large) which we adopted as a regular supply with the Stereo-campimeter.

"The construction of the apparatus is as follows: An oblong base fitted with a vertical pillar serves as the support of the object stage and stereo-attachment. The stage is 11x½ in. long and 7 in. wide with an opening of 4x9 in., and is provided with a millimeter scale on the right and left side. These scales serve as orientation scales for the position of the charts and which may be of various sizes. The stage, being a metal frame, is covered with a ground glass plate; two metal bars provided with guiding springs are fitted to the stage so that same may be moved right across the entire stage. This arrangement allows to place the charts of various sizes and dimensions on the stage and to hold same firm and flat to the surface of the stage by means of these adjustable metal bars. The stage itself may be moved nearer or farther away from the Stereo-campimeter lenses, which movement serves as a focusing arrangement. Two metal rods are provided on which the stage slides and one of the metal rods is graduated in one-half centimeters so that any position of the stage may be recorded. When the large Lloyd campimeter slate is to be used

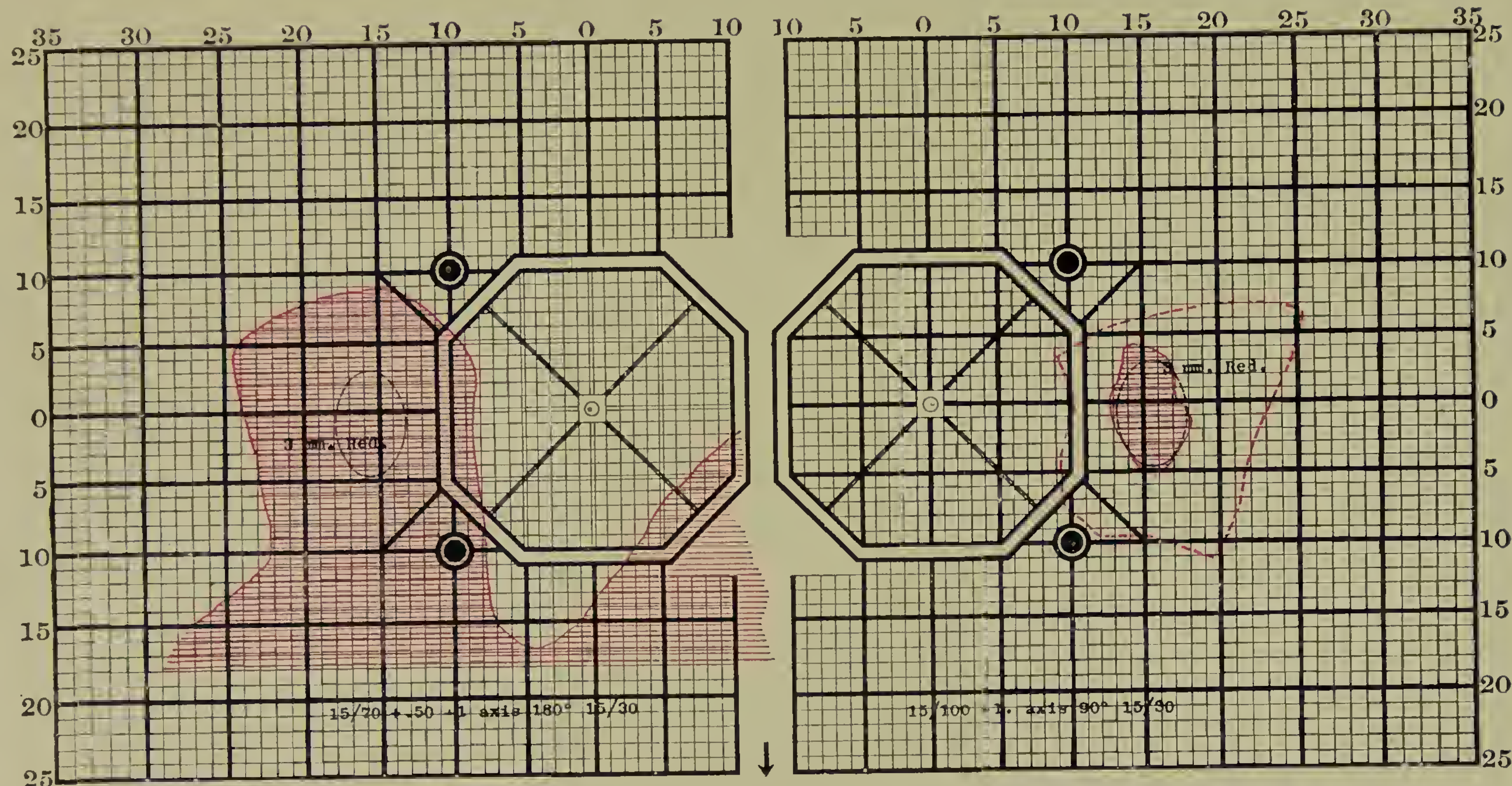


Fig. 38.—Chart for Use with the Wide-Angle Stereoscope, Showing the Early Stage of Glaucoma. (*Lloyd.*)

on the Stereo-campimeter, the metal bars on the stage are removed and the Lloyd campimeter slate, provided with metal grooves at the back surface, is then slipped over the stage. The stereoscopic lens system provided with a light excluding screen is mounted to a strong metal carrier which in turn is rigidly fixed to the object stage. The lenses themselves are of a meniscus form corrected for an angle of 60° and free from astigmatism of oblique pencils over the entire

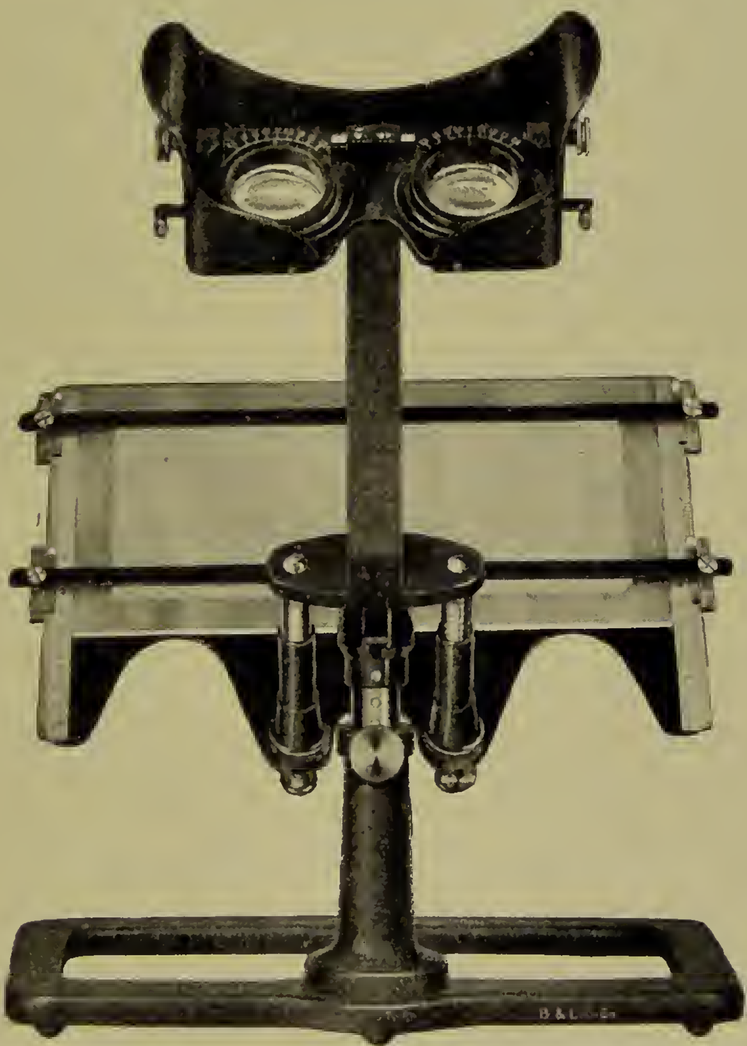


Fig. 39. The Stereo-Campimeter (Wide Angle Stereoscope). Bausch & Lomb.

field of view. The diameter of the lenses is about 40 mm. and the focal length 190 mm. The optical centers of the lenses when in correct position are 80 mm. apart. Each lens is provided with a lateral screw adjustment and millimeter scale with index to record the position of the axis of the lens. Each lens may also be rotated about its optical axis over an angle of 180°. A scale with index is provided for either lens, indicating one-half prism diopter values the rotation of the lens when used in conjunction with a prism of 3.0 prism

diopter. The scale ranges on either lens from 0 to 2 prism diopter. A lever with milled head is provided on either lens mount in order to facilitate the rotation movement. At the lower end of the light excluding screen each lens mount is provided with a groove and spring clip to receive prisms of various powers. The range of these prism powers supplied with this instrument is 2.5, 3, 4, 5, 6 and 7 prism diopters, which enables one to select the exact amount of prism required for each patient. The correct position of the stage surface from the principal points of the lenses is 190 mm., i. e., the chart is situated precisely in the focal plane of the lenses. The exit pencil is therefore parallel, making an adjustment for interpupillary distance for the various observers superfluous. Nevertheless, lateral adjustment devices for the lenses have been provided to facilitate experimental work. The stage together with the stereoscopic lens system may be inclined and also adjusted in height to suit the convenience of the patient and allows full inclination over an arc of 90°. A substantial hinge is provided to secure firmly the position of the entire viewing apparatus. The light excluding screen is constructed of vulcanite and the object stage of hard brass. The sliding rods for adjustment of stage are of steel and the remainder of the apparatus is constructed of a special aluminum alloy to insure lightness but nevertheless rigidity. The angle of view indicated on the Lloyd campimeter slate extends in a vertical direction from the center of field 25° (up or down), comprising a total angle of 50°. The angle from center to margin of field temporal is 35°, nasal 10°. The field of view of the specially constructed stereo lenses extends considerably beyond these dimensions but Dr. Lloyd limited his slate within the dimensions mentioned above. The instrument may be used for either transparent or opaque charts and is usually furnished with a set of Haitz charts, one Bissell blind spot slate and one Lloyd campimeter slate, with respective record charts; also one each test objects, 1.5 mm., 3 mm., 5 and 10 mm. of the various colors, namely, white, red, green, blue, and a Wells chart. In using the instrument the Wells chart is inserted in the clips and the patient is asked at what figure the red line crosses the black and if not at 8 the prism is changed until this result is secured. It is then noted at what letter the black line crosses the red. If not at G, the necessary vertical adjustment is made. The instrument is thus adapted for this particular patient to fuse without effort all charts whose corresponding points are 8 cm. apart. The lines of this Wells chart are made heavy, (2 mm. in width) and the figures enlarged, in order that they may be easily seen even though the visual acuity of the eyes be poor. An ametropic patient must wear his full correction for distance when a test for scotoma is made."

DISTANCE STEREOSCOPES.

The opera glass. One of the earliest instruments for increasing the stereoscopic power in the distance is the familiar *opera glass.* This is really a double simple telescope. It was introduced by a Dutchman, Voigtländer, about 1830, and continued to be the only practical apparatus for both in-door and out-door work, the latter with larger objectives, until 1893. The later improvement came in the introduction by Abbé of the Porro prism which gives four reflections with reversion of the picture and lateral transposition of the rays. This addition made the instrument a little too cumbersome for the opera, but quite practical as a field glass. The increased stereoscopic effect is produced by an artificial lengthening of the pupillary distance or base line, earlier (1857) accomplished by Helmholtz in his mirror stereoscope.

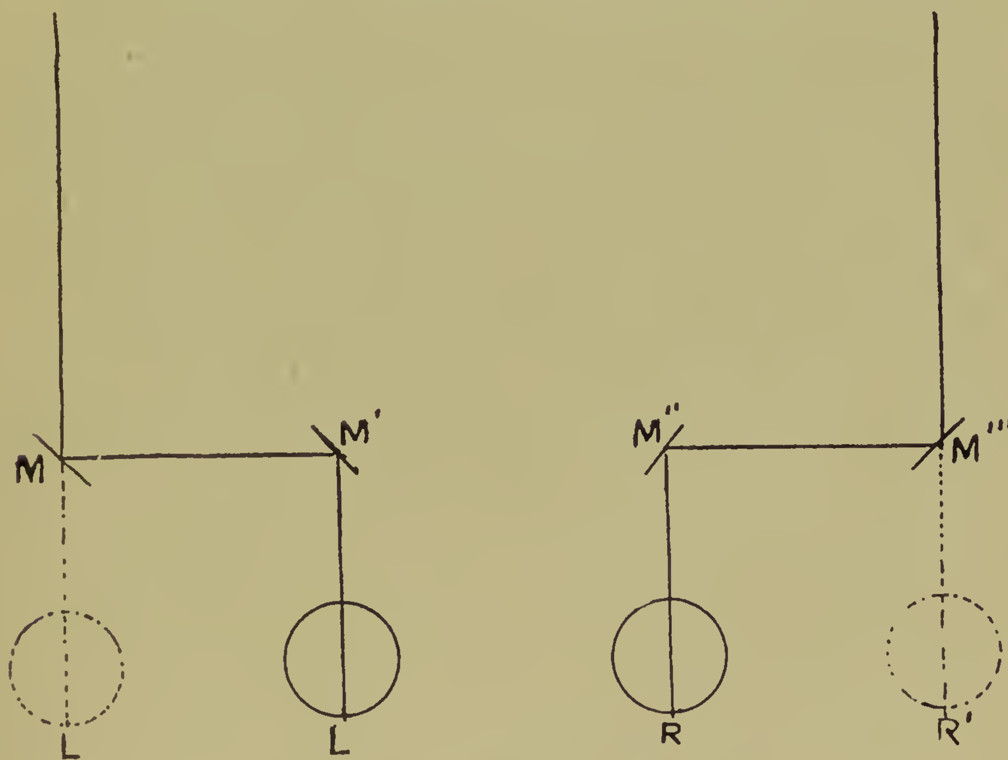


Fig. 40. The Helmholtz Telestereoscope.

Tele-stereoscope. The mirrors M, M′, M″, M‴, are so arranged that light enters the eyes, R and L, as if they were separated as widely as R′ L′. This increases the binocular parallactic angle and so gives relief to distant objects which without its aid would appear flat. See Fig. 40.

Measurement of stereoscopic acuity (see **Stereoscoptometer**). Pulfrich, 1899, introduced the *Stereotelemeter* (q. v.), a stereoscopic instrument for measuring distance. See **Distance, Estimation of,** p. 4045, Vol VI of this *Encyclopedia.* Pulfrich found that some of the officers could not use this instrument because of defective binocular vision and was thus led to investigate the faculty as a result of which he announced that persons with normal eyes have a power of perception of depth of 10″ and a visual acuity (monocular) of a smaller angle.

The James distance stereoscope. In 1908 Brooksbank James published in the *Lancet* a paper on this subject, although it would seem that his instrument should be called a *stereoscoptometer.* He says:—"The general form of this apparatus, which may be called a distance stereoscope, when in use, is that of a box, the roof and side walls of which have been removed, leaving the anterior and posterior walls and floor. The anterior wall measures 38 cm. transversely by 31 cm. vertically. In its center is an oblong window, 19½ cm. by 12 cm. The whole of the anterior wall, with the exception of the window, is covered with black velvet. The posterior wall consists of a central portion 38 cm. by 13 cm. and two rings, each 19 cm. by 29 cm. The whole of the posterior wall is covered with black velvet. The floor measures 38 cm. transversely by 38.5 cm. in an antero-posterior direction. It presents two longitudinal grooves in which run two carriers to support the test objects; the grooves are placed at equal distances from the margins of the window of the box and there is an interval of 50 mm. between them. These measurements of the different parts of the stereoscope are just sufficient to permit of its use in the way I am about to describe.

"The test objects are sticks of different sizes painted a pure white. Their length is such that when a stick is in position its extremities are hidden from view by the margins of the windows of the box. For clinical observations the box is placed at a distance of six meters from the observer, just beneath the ordinary board printed with the Snellen types. A stick is inserted in one of the carriers and the latter is placed at a distance of 80 mm. from the window of the box and in a plane with the test-type board. A second stick is inserted in the other carrier, which is then run backwards along the groove for a variable distance according to the interval between the nodal points of the observer's eyes, as will be presently explained." He calculated the stereoscopic parallax for a P. D. 60 mm. at 6 m. distance and horizontal separation of sticks 60 mm. as follows:

"R and L are the nodal points of the right and left eye distant in

the assumed case 60 mm. apart. W W is the window of the box. A is the anterior stick, distant 6 meters, i. e., 6,000 mm. from the eye. B is the posterior stick distant 6,180 mm. from the eye. S V is a plane passing through A parallel with the window of the box. The lateral separation of the two sticks in this plane is taken for convenience of calculation as equal to the base line, i. e., 60 mm. Join

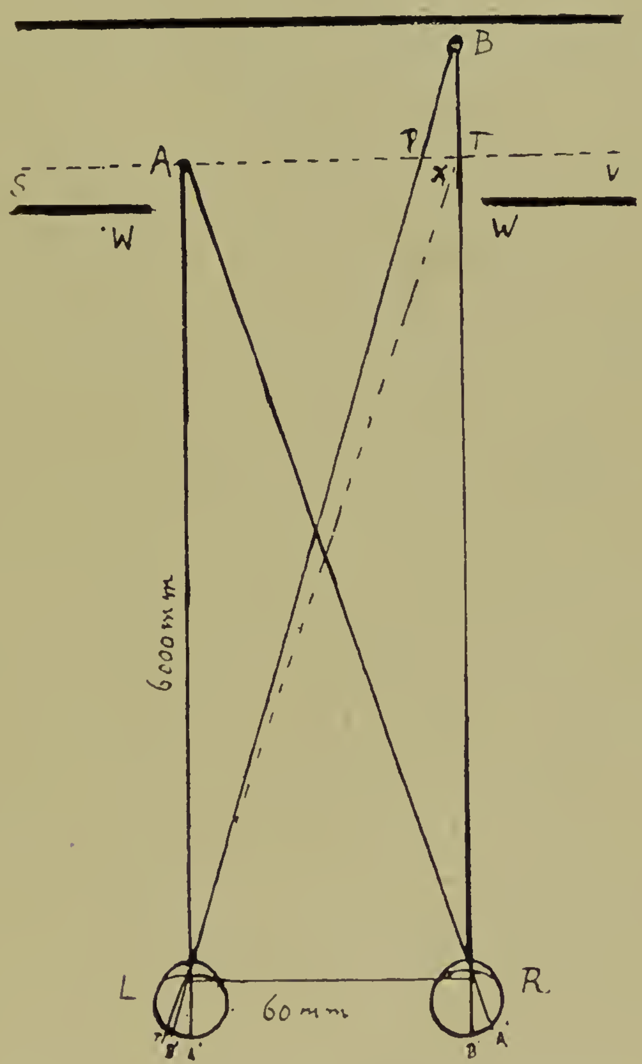


Fig. 41. Stereoscopic Parallax. (James.)

RB, RA, LB, LA; RB cuts SV, which we may call the picture plane, at T and LB cuts this plane at P; RB and LA are parallel. Now, it is obvious that the angle BRA is the angle subtended at the nodal point of the right eye by the two objects B and A, and AT is the value of this angle as depicted on the picture plane. Similarly the angle ALB is the angle subtended at the nodal point of the left eye by the two objects A and B, and AP is the value of this angle as depicted in the picture plane SV; PT is therefore the difference between

the chord of angle of the stereoscopic parallax BLT. We require now to know the value of PT in mm.; when the distance of the anterior stick = 6,000 mm., the distance of the posterior stick = 6,180 mm. and the base line = 60 mm. Let X = the stereoscopic parallax PT.

The triangles LAP and BTP are similar—therefore''

$$\frac{AP}{AL} = \frac{PT}{TB} \quad \text{i. e.} \quad \frac{60-X}{6000} = \frac{X}{180}$$

$$6000X = 10800-180X$$
$$6180X = 10800$$
$$X = 1.74 \text{ mm.}$$

but $\frac{1.74}{6000} = 0.000290 =$ approximately the chord of *an angle of 1′*

''We find, therefore, that if an observer is situated six meters from the front stick, and if his base line = 60 mm. and the posterior stick be placed 180 mm. behind the plane of the anterior stick, the angle *of the stereoscopic parallax is 1′.* This is the same angle subtended by each line of the letters in the No. 6/6 of the Snellen types. We can, therefore, infer that a patient who can distinguish the relative distance of the sticks under these conditions must have a visual acuity of 6/6, and we shall find that this is practically the case. Jam found the instrument also an aid in training those cases of convergent squint whose eyes by operation or orthoptic exercises have become approximately parallel.''

The stereoscope as a test for judgment of distance. The most accurate experimentation on this subject was made by Capt. Harvey J. Howard at the Medical Research Laboratory of the Air Service, U. S. Army, Hazelhurst Field, Mineola, Long Island, and from his paper (*Trans. Am. Ophthalm. Soc.,* 1919) the following excerpts have been made: ''The much discussed question of the judgment of distance has suddenly come to have, through the advent of military and naval aviation, a very important and practical application. The literature on the subject is voluminous. One finds, however. that it is rich in the amount of theory from the physiologic, psychologic and philosophic viewpoints, but exceedingly meager in experimental data, most of which were published several decades ago. It is the practical phase and consequently the experimental data which most concern those of us interested in the examination and classification of applicants for the aviation service. We are eager to know how and why we are able to judge distance, but our chief object

is to learn what the individual ability of men along this line actually is.''

Status of the present test. ''The test for the judgment of distance is referred to in our aviation manual as the test for 'stereoscopic vision.' '' For this purpose a hand stereoscope, with specially made sets of stereoscopic charts is used. In the majority of cases this test is satisfactory as far as it goes. But it does not permit of any except rough distinctions. No accurate classification, based on a subject's relative ability, is possible.

''On the grounds that there are flyers now in the service with faulty binocular vision and a few with only monocular vision, some examiners have questioned the absolute necessity of binocular single vision as a preliminary requirement. Upon sober reflection, however, one must conclude that the knowledge that a number of men with faulty binocular vision have been admitted to flying service and are still living, does not constitute a proof that even a larger number have not met an unnecessary death on account of having been wrongly permitted to fly. It is error in judgment of distance in landing a plane that has caused the great majority of deaths among cadet aviators.''

Consideration of factors involved in judgment of distance. ''Judgment of distance is dependent upon several factors. Some of these factors operate both monocular and binocular vision alike. The others act only when binocular single vision is present. In brief, the latter possesses all the factors that monocular vision has, and in addition has at least two others. The distinctions may be represented as follows: A. Factors common to both binocular and monocular vision. 1. Size of the retinal image. 2. Accommodation. 3. Motion parallax. 4. Terrestrial association: (a) Linear perspective, (b) Overlapping of contours, (c) Light reflections and shadows. 5. Aerial perspective, i. e., the changes with respect to color, brightness and contrast which distant objects undergo on account of variations in the clarity of the intervening atmosphere.

B. Factors operating only with binocular single vision. 1. Binocular parallax. 2. Convergence.

''In employing a test for the purpose of classification it is necessary to utilize only that factor or those factors which operate to make for an individual difference in ability. All other factors should be eliminated in such a test.

''In searching the literature I was fortunate in finding the description of an apparatus devised by Brooksbank James (*Lancet*, p. 1763, June 20, 1908). [See the sub-caption, *The James distance stereo-*

scope, in this section.] With a few modifications and the addition of a head rest this seemed to meet all the requirements."

By a more exact mathematical process than that of James, Howard has worked out the angle of binocular parallax for depth distances of 5 mm. to 360 mm. and for interpupillary distances from 57 to 72 from which the table (Fig. 43) is abstracted.

One hundred and six aviators were examined. The tests commenced with a depth difference of 30 mm., twenty judgments being taken. The depth difference was decreased until a point was reached at which 25 per cent. of the answers were wrong, and this was considered the individual's threshold.

Howard gives the following *conclusions:* "1. Of all the personal factors which aid us in the judgment of distance, the binocular parallax is the most important. By experiment it was found to possess twenty times the ability of the retinal image or visual angle which is the important factor in monocular judgment. This, however, should not represent the comparative depth judgment skill of two- and one-eyed persons, because in actual life the extraneous factors by helping both equally, serve greatly to lessen the difference in ability of the respective personal factors.

"2. The minimal binocular parallactic angle varies greatly with individuals. It depends upon such factors as visual acuity, equality of visual acuity or visual balance, muscle balance, interpupillary distance, and probably some innate and acquired ability.

"3. Fourteen observers (twelve of whom were pilots) out of one hundred and six examined were found to possess judgment of distance to a remarkable degree. Their binocular parallactic angles ranged from 1.8″ to 2.0″ with an average of 1.89″.

"4. To possess normal judgment of distance one's binocular parallactic angle should not be greater than 8.0″ when the test is performed with an apparatus made on the principles of the one used for these experiments.

"5. An apparatus like the one used in this experiment is free from the criticism of the hand stereoscope. Furthermore, it permits of classification of individuals according to their discriminating ability. In view of the different requirements in various forms of military aviation it would be an advantage to be able to assign successful applicants to special training according to their different degrees of ability.

"6. The value of such an apparatus is greatly enhanced and much smaller discriminations are possible by giving the observer a sudden impression of the objects to be judged. Otherwise there is apt to be

a discriminating fluctuation of those objects. Most of our natural binocular judgments are more or less instantaneous. Therefore the shutter on the apparatus is an important requirement.

"7. The binocular parallax operates in the judgment of objects maintaining some horizontal or lateral separation, but not for superimposed objects like telegraph wires. In the latter instance judgment is dependent upon the interpretation of the retinal images when all factors extraneous to the individual like terrestrial and aërial perspective are excluded.

"8. To estimate correctly the position of an object one must know its direction and distance. Direction is judged more accurately with one eye but distance better with both. To be denied the privilege of using either one or two eyes at will would be a distinct disadvantage to an aviator.

"9. The reaction time required to make monocular judgments of distances is very slow, whereas binocular judgments are practically instantaneous.

"10. A tendency to project one image nearer than the other was found in 23 out of the 106 subjects. Some showed this tendency to a marked degree. Although some of these cases had muscle imbalance, others visual asymmetry and still others had both these abnormal conditions, the phenomenon cannot be explained satisfactorily.

"11. The wide variations in the visual angle and binocular parallactic angle thresholds according to the experiments herein recorded make it evident that the two angles have nothing to do with each other. It is a mistake therefore to assume because the cones in one's retina are limited up to a certain distance apart, that one's binocular parallactic angle must necessarily be limited to the size of the visual angle representing that distance.

"12. The effect of low oxygen on the depth perceiving sense is of little importance because, at the critical time during the flight, which is the landing, there is no lack of oxygen."

In order to determine the practical value of this 6 meter test as a measure of depth difference perception at greater distance, semaphore tests at 100 meters were made. The semaphores were 13 cm. diameter, that is thirteen times the size used at 1 meter, so as to subtend the same visual angle. Seven of the subjects had been previously examined with the six meter apparatus. An average of 5 meters difference in distance of the semaphores was recognized. This corresponds to parallactic angle 5.1″, the 6 m. test gave 5.9″, which shows that the 6 m. test is practically accurate. These facts do not agree with the statement of Eaton (*Brit. Journ. of Ophthalm.*, Vol.

III, 1919) that "fusion sense," as he prefers to call the binocular factor of depth perception "can not play any part at distances greater than 120 yards." The data of Eaton's experiments might help to settle the discrepancy, but none is given.

"It should also be of interest to learn the results of an examination made with observer No. 8 the day following his first trial. On the second day there was low visibility on account of a moderately heavy fog and a cloudy sky. His depth-difference threshold the first day was five meters, while on the second day it was eleven meters. That is, his binocular parallactic angle was 12:67″, or more than twice that of the preceding day."

Conclusions regarding the binocular parallax. Howard believes: "1. The binocular parallax, even when acting alone, is capable of great depth perceiving power. 2. The binocular parallactic angle is computed from the depth differences of objects looked at, and from one's interpupillary distance. The minimal binocular parallactic angle varies greatly with individuals and seems to have a physical basis. From data collected it seems to be dependent upon visual acuity, visual symmetry and muscle balance to a large extent. 3. Subjects examined with the 100 meter apparatus showed binocular parallactic angles varying from 3.37″ to 7.53″, with an average of 5.19″. 4. The findings with the outdoor test coincide very closely with those of the six meter indoor test, but do not warrant its substitution for the latter. 5. The size of the visual angle or the retinal image has nothing to do with the binocular parallactic angle. It is wrong, therefore, to associate the visual angle with binocular discrimination of distance. The visual angle threshold is often stated as being about one minute, whereas the binocular parallactic angle threshold has been found to be as small as 1.80″. 6. Our 'fusion sense' or our binocular depth perceiving ability theoretically is of value up to a distance of several thousand meters. Practically it is less, because we are limited by our visual acuity."

The angle of normal binocular parallax. That further experimentation is necessary for establishing the normal stereoscopic parallax (if such exists) is evident from the data at hand. Pulfrich gives 10″; James gives 1′; Howard gives 8″; the Mineola laboratory adopted 9″ to 11″.

A large number of further independent observations are desirable.

James maintains that the *visual acuity corresponds to the stereoscopic acuity* so that the measurement of the latter suffices for both. Howard says there seems to be no definite relation between the two. James has furnished no data of actual number of observations, and

was evidently biased by the assumption that the binocular parallactic angle must be the same as the *accepted* angle of visual acuity, namely 1′; although Pulfrich had shown previously (*Encyclopedia Britannica*) that "It is not essential that the two image-points should be separated from one another by the distance of the two nerve filaments of the eyes."

Wundt and Bourdon (see p. 10115, Vol. XIII of this *Encyclopedia*) determined that with a thread at 50 cm. the average depth difference threshold was 1 cm. This equals a parallactic angle of 9′+, but the conditions of the experiments are so entirely different from those of James and Howard that it is probably of no value to compare them.

In determining the value of Howard's contribution (undoubtedly great) to our knowledge, it must be remembered that he was dealing with picked men, many with abnormally acute vision.

Before deciding the question a large amount of data should be furnished by many experimenters. That the results may be comparable the following standard conditions should be observed: First, observations should be made at 6 m.; second, that the horizontal separation of the objects be equal to the pupillary distance; third, that the diameter of objects be 1 cm.

That this may be made a routine feature of every examination, some inexpensive and practical apparatus is needed.

Cohen's distance stereoscope. Cohen (*Archives of Ophthalm.*, March, 1919) has constructed a "distance stereoscope" which supplies this need. It consists of a black cylinder 30 cm. in diameter and 40 cm. long. It is mounted on a tripod, the open end being toward the observer. Tubes carrying miniature electric lights pierce the back of the cylinder, and are adjustable in the antero-posterior direction, allowing of a difference in distance of 20 cm.

The original model had four such tubes arranged quadrilaterally. This has been modified by the writer, so that only two lights are used and these are placed in the horizontal plane.

The lights are covered in front with white porcelain glass showing luminous discs of 25 cm. diameter. The Cohen apparatus overcomes the difficulty of proper illumination of the rods alluded to by both James and Howard, and as the patient sees nothing inside the cylinder except the luminous discs there is no possibility of a monocular estimation of distance. In front of these Cohen used stencil screens showing the block letter "E" in different positions. Different colors of glass were also provided. As simplified by the writer one of these discs is diaphragmed down to 1 cm. adjustable in the horizontal so that the separation can be made to correspond to the pupillary dis-

tance. The other luminous disc was first covered with an iris diaphragm so that the disc could be made to correspond exactly with the other, or made larger or smaller.

This ability to make the horizontal separation agree with the pupillary distance is important, because it simplifies the calculation of the angle of stereoscopic parallax by furnishing right angle triangles for the varying pupillary distance.

Fig. 42. Cohen's Distance Stereoscope Modified by Wells.

James suggested that the farther rod be about .5 mm. larger than the nearer, so as to exclude a judgment based on the size of the retinal image, and the iris diaphragm was adopted by the writer in deference to his opinion. The difference in size necessary for different depth distances was worked out and found to be so slight (.03 mm. for 2 cm.) that it is negligible, and therefore the two discs are now used of equal size, 1 cm.

As the tubes which project back of the cylinder are marked in 5 mm. divisions, it can be quickly noted how small a depth difference

Inter-pupillary distance.	Antero-posterior separation of objects in mm. 5	10	15	20	25	30	40	50	60	90	120	150	180	210	240
58	1.6″	3.3″	4.9″	6.6″	8.2″	9.9″	13.2″	16.4″	19.7″	29.4″	39.0″	48.6″	58.0″	67.4″	76.6″
59	1.6″	3.3″	5.0″	6.7″	8.4″	10.0″	13.4″	16.7″	20.0″	29.9″	39.7″	49.4″	59.0″	68.5″	78.0″
60	1.7″	3.4″	5.1″	6.9″	8.6″	10.3″	13.7″	17.1″	20.5″	30.7″	40.7″	50.7″	60.5″	70.3″	79.9″
61	1.7″	3.7″	5.2″	6.9″	8.7″	10.4″	13.8″	17.3″	20.7″	30.9″	41.1″	51.1″	61.0″	70.9″	80.6″
62	1.7″	3.5″	5.3″	7.0″	8.8″	10.6″	14.1″	17.6″	21.1″	31.4″	41.7″	51.9″	62.0″	72.0″	81.9″
63	1.8″	3.6″	5.4″	7.1″	8.9″	10.7″	14.3″	17.8″	21.4″	32.0″	42.4″	52.8″	63.0″	73.2″	83.2″
64	1.8″	3.6″	5.4″	7.3″	9.1″	10.9″	14.5″	18.1″	21.7″	32.5″	43.1″	53.6″	64.0″	74.3″	84.6″
65	1.8″	3.7″	5.5″	7.4″	9.2″	11.1″	14.8″	18.4″	22.1″	33.0″	43.8″	54.4″	65.0″	75.5″	85.9″
66	1.8″	3.7″	5.6″	7.5″	9.4″	11.2″	15.0″	18.7″	22.4″	33.5″	44.4″	55.3″	66.0″	76.7″	87.2″
67	1.9″	3.8″	5.7″	7.6″	9.5″	11.4″	15.2″	19.0″	22.8″	34.0″	45.1″	56.1″	67.0″	77.8″	88.5″
68	1.9″	3.8″	5.8″	7.7″	9.6″	11.6″	15.4″	19.3″	23.1″	34.5″	45.8″	57.0″	68.0″	79.0″	89.8″

Fig. 43. Table of Binocular Parallactic Angle. (Howard.) Nearer object 6m.; size of object 1 cm.; separation of objects = P.D.

is recognized. No one ever records visual acuity in terms of the visual angle but as 20/20 or 1. It is therefore evident that the depth difference will be the unit of measurement, when stereopsis becomes a part of a complete ocular examination. Whenever one wishes to know the parallactic angle, he may refer to the preceding table which is abstracted from Howard's very exhaustive calculations.

Stereomicrometer. (An instrument of precision for measuring stereopsis. Description furnished by Capt. Howard.)

Stereoscopic pictures of figures viewed through a stereoscope produce an illusion of solidity or depth which simulates one of our most common visual experiences, viz., true depth perception. The effect produced is merely an illusion because in reality the two pictures are in the same reference plane, i. e., there is no difference in distance. The phenomena of depth and depth difference are produced by employing the principle of binocular parallax. Objects are made to appear relatively nearer or farther away from the observer simply by varying the lateral separation between identical objects or points in the two pictures. For instance, let us select two pairs of identical points in the two pictures. If we find the lateral separation between one pair is 63 mm. and between the other pair 64 mm., the point represented by the fusion of the two more widely separated points will appear farther away than the point represented by the fusion of the two less widely separated points.

While working upon the subject of judgment of distance with an apparatus employed at a distance of six meters ("A Test for the Judgment of Distance," *Trans. Am. Ophth. Soc.*, 1919), one of my co-workers, Captain Percy W. Cobb, suggested that I adopt the same form of test objects in a hand stereoscopic instrument of precision for the purpose of producing any degree of depth illusion desired. In the six meter apparatus two black rods with a light surface background were viewed through the window of a box, the purpose being to learn the smallest depth difference discernible by different individuals. The binocular parallax was found to be the essential factor in the resultant determinations. The respective depth judgment ability of individuals was reckoned according to their minimal binocular parallactic angles, which were computed from interpupillary distances and depth difference thresholds.

In the hand stereoscopic instrument suggested there would be two pairs of vertical lines or objects to be fused. To produce a sense of depth the only other essential would be to effect a different lateral separation between the pairs of fused objects, i. e.. the binocular paral-

lax would be applied directly and not indirectly as is the case with the non-fused objects of the six meter apparatus.

In addition to Captain Cobb, I am indebted to Mr. Max Poser of the Bausch and Lomb Optical Company for valuable suggestions in formulating the final plans for the instrument. Authority to make according to specifications granted February, 1919, to the Bausch and Lomb Optical Company by the Supply Department, Hazelhurst Field, Mineola, Long Island, N. Y.

Description of the instrument:

Figure 44 represents a photograph of the completed instrument.

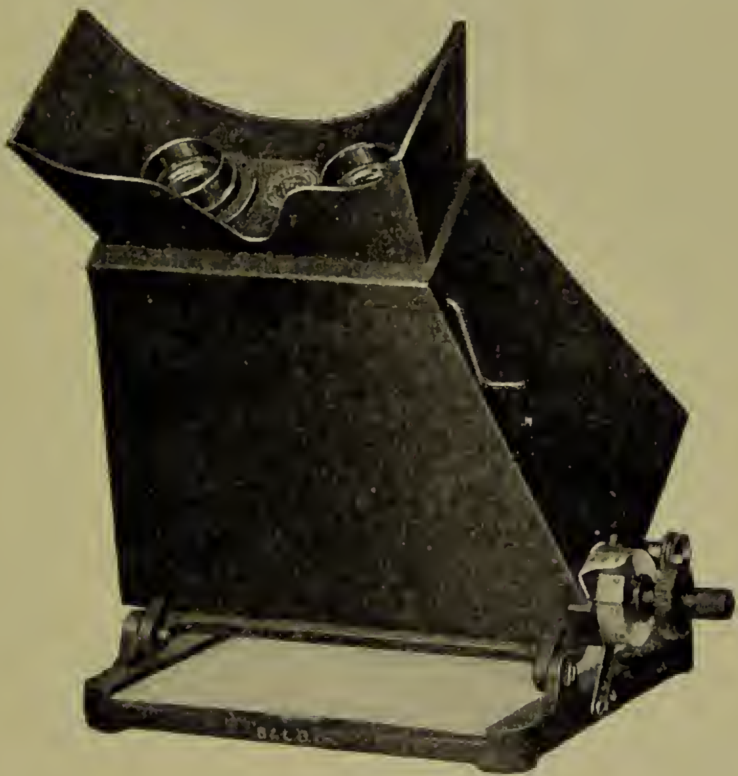


Fig. 44. Stereomicrometer.

Roughly it is about nine inches high, six inches wide and five inches deep.

Inside the box are the four test objects which are a pair of wires on each side 1.375 mm. apart, which gives them an angular separation from the center of the lens of exactly one centrad. This angle was decided upon because in experiments with an apparatus at six meters and another at one hundred meters, the centrad separations of the test objects had always been used. From this standpoint therefore the results of all three forms of apparatus should be comparable. The lenses are as carefully made and adjusted as are those in a pair of field binoculars. Each lens has a focal length of 137.5 mm.

At the right side of the instrument is a micrometer screw which has a lateral movement of exactly 0.5 mm. for each revolution. Attached to the axis of the screw is a drum with its peripheral surface marked off into 100 equal parts. Each division on this scale represents a lateral shift of the screw of 0.005 mm. Attached to the axis of the screw there is also a double turning knob. Fixed in a horizontal position at right angles to the drum is a metal plate marked off into a 0.5 mm. scale. Within the box the micrometer screw butts firmly against the long end of a lever. With a leverage of five to one, the short end is attached to a bar which holds in position the right hand wire. To take up all slack and lost motion a spring is fixed, one end to the movable bar and the other end to a position inside the instrument. The other three wires are maintained independently of the fourth and in fixed positions. The effect of the five to one leverage is to reduce the lateral movement transmitted through the micrometer screw to the right hand wire to one-fifth that of the screw. One division therefore on the micrometer scale represents a lateral movement of that wire of 0.001 mm. or one micron.

Attached to the bottom of the metal stereoscopic box is a base plate of metal upon which the box can be tilted and fixed by a set screw in any position from 90° to 180°. In the upper edge of the base plate is set an opaque milk glass to give an indirect uniform light background for the wires above it.

Behind the lenses is a shutter which is attached to a wire lever protruding through the upper right hand side of the box. By manipulating the wire lever the examiner or the subject himself is able to produce practically an instantaneous view of the wires, which effect was found to be so valuable in the experiments of the six meter apparatus.

The test is made by requiring the subject to set the wires into what he thinks is the same reference plane, i. e., equidistant from his eyes. After a number of such trials the average error represents his binocular parallactic angle threshold. This threshold is computed in seconds by adding fifty per cent. to the reading on the scale representing his average error. For example, if the scale reading is ten divisions from the zero mark, then his minimal binocular parallactic angle is 15″. With such an instrument it is possible to classify individuals according to their respective degree of stereopsis. With those who have this ability of fusing stereoscopic objects, i. e., nearly all those having binocular vision, this classification should represent their respective ability to judge distance. This instrument should offer a far more satisfactory test of stereoscopic vision than the ordinary hand stereo-

scope which has been used almost universally in testing candidates for aviation service.

The instrument perhaps offers a more direct application in testing and classifying candidates for the naval and artillery services, where according to recent communications the men may be required to use stereoscopic range finders. During the war it was known that the central powers used stereoscopic range finders almost exclusively. The entente powers on the other hand used various forms of coincidence range finders, but towards the end of the war the U. S. authorized the manufacture in this country of a number of stereoscopic range finders. The comparative results with the two forms of range finders will depend very largely upon the selection of the men using them. By means of the stereomicrometer it should be possible to select only those who possess the highest degree of stereopsis or judgment of distance. This group should show such a remarkable ability with the stereoscopic range finder that its use may eventually be adopted in place of the ordinary coincidence type.—(D. W. W.)

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Stereoscope-optometer. See **Baldanza's test,** p. 867, Vol. 11 of this *Encyclopedia.*

Stereoscopic image. An image in relief due to the production on corresponding portions of the retina of each eye of an optical image appropriate to that eye.

Stereoscopic microscope. A binocular microscope, giving a stereoscopic image.

Stereoscopic relief. The sensation of solidity due to the fusion of dissimilar retinal images.

Stereoscopic silhouettes. H. V. Würdemann *(Am. Journ. Ophthalm.,* p. 275, April, 1919) has further modified a *stereoscopic test for bin-*

Stereoscopic Silhouettes for Testing Sense of Distance or Depth.

ocular vision and estimation of distances, which had been republished by Carl Zeiss, of Jena. Photographic copies of these plates were in use by the Examining Boards for Aviators of the Signal Corps of the United States Army. These were in the German language and as their use in this form for this particular purpose did not seem to be patriotic the writer appropriated the unknown author's ideas in toto as the spoils of war. Würdemann has redrawn the plates and translated the lettering into the English language. The plate herewith pictured and described is exactly the same so far as the drawing goes as that in the German; so that no claim to originality whatever is made in this reproduction.

The writer had the original enlarged five times by photography and

redrew the pictures, substituted for the German legends their meaning in English and had it reduced to stereoscopic size by photo-engraving.

The difference between the lateral centers of each picture in the stereoscopic engraved reproduction varies according to the following: The distances between numbers 9 and 9 are 66 mm.: between numbers 10 and 10, 68 mm. The objects numbered between these are 1/5 mm. more or less apart. The scale reading 9 for the nearest, 1, 7, 3, 4, 5, 6, 8 and 10. There is a slight variation in the picture to give a certain amount of stereoscopic perception of depth and aiding in the perception of distance.

No. 9 Gate in Lübeck, should seem the nearest, No. 1, Hohenzollern Castle next, then in the following order, 7 Holtenauer Lighthouse, 3 Cologne Cathedral, 2 Wartburg, 4 The Berlin Dome, 5 Lichtenstein Castle, 6 Zeppelin over Strassburg, 8 German Battleship "Kaiser Friedrich" and 10 which is the farthest away, German School Ship "Stein."

This is the most delicate test for binocular vision and for the perception of depth or distance. Any candidate for aviation who does not correctly answer these in the notation and rotation as above given has an imperfect perception of depth and distance and is not qualified for either a flyer or an observer. In civilian practice, the same condition holds good as when the numbers are properly stated there is evident perfect binocular vision. Persons with esophoria or exophoria beyond what may be esteemed the normal condition, i. e., not more than 5° esophoria or 3° exophoria for infinity or 6° exophoria for 30 cm. can not as a rule solve this chart as do those with perfect muscular balance.

Stereoscopic vision. That form of vision when the images formed on the retinas of both eyes are combined into a single representation in relief. This subject is treated under various captions in this *Encyclopedia*, e. g., on p. 3829, Vol. V; also on p. 970, and on p. 973,Vol. II; also under **Hering's experiment**, p. 5877, Vol. VIII, and very fully under **Stereoscope**.

F. Best (*Ophthalmology*, p. 635, July, 1913) believes it is practically possible to determine the stereoscopic visual acuity with almost the same accuracy as the visual acuity. The writer found that in impaired vision of one eye in consequence of corneal opacities the stereoscopic vision decreases parallel with vision. Stereoscopic vision is generally more diminished by difference of refraction and congenital amblyopia. In high hypermetropia, myopia, and astigmatism, the stereoscopic visual acuity may be normal, but frequently is impaired.

That there is a distinction if not a decided *difference* between *per-*

spective vision and *stereoscopic vision* is well argued by Isadore Franklin (*Am. Jour. of Ophthalm.*, April, 1918) who says that *stereoscopic vision* may be defined as the sense of seeing an object from two different aspects, which through the association of stereoscopic memory gives the impression of solidity. *Perspective vision,* on the other hand, may be defined as the sense of seeing objects at varying distances, which through the association of memory of bodily or limb excursions through space, produces a vivid sense of depth.

In case of stereoscopic vision, it suffices to fix an object with both eyes to get a complete sense of solidity. The muscles of convergence and accommodation, though in use, are not called into "play." Whereas to obtain a complete sense of depth, it is necessary to converge and accommodate for varying distances. The difference is therefore quite clear: One is static and the other principally dynamic in its nature.

On analyzing the two senses, even apart from their psychologic aspects, the elements that enter into their make-up are surprisingly numerous and complicated. The following are the factors which separately or in combination produce the effects of stereoscopic and perspective vision:

Elements of stereoscopic vision or sense of solidity. (1) Sense of seeing an object from two different aspects. (2) Sense of completeness of image through the mutually complementing effect of two different images. (3) Shadow effects. (4) Augmenting effect of perspective vision.

Elements of perspective vision or sense of depth: (1) Sense of seeing objects at varying distances through (*a*) the play of the muscles of convergence; and (*b*) the play of the muscles of accommodation. (2) Blurring of part of the field of vision in an antero-posterior direction, due to (*a*) doubling in front and beyond point of convergence; (*b*) being out of focus in front or beyond point of accommodation; (*c*) diminution of images below visual angle with increasing distance; and (*d*) atmospheric effects. (3) Relation of size of images to distance. (4) The relative position of objects in which we are accustomed to find them. (5) The enhancing effect of stereoscopic vision.

Franklin further points out that the sense of seeing an object from two different aspects is the most important element in stereoscopic vision. This factor, however, is in its turn composed of the following separate elements: (*a*) sense of converging muscles; (*b*) sense of common source of rays [identical location of image on both retinas with respect to field of vision, same side]; (*c*) sense of difference of the two retinal images. Though the sense of converging muscles is normally a factor in producing the sense of common source of rays, it is not

essential, since it may be replaced by prismatic effects. Furthermore, both factors combined, (*a*) and (*b*), are incapable of producing a stereoscopic effect without the aid of factor (*c*), since merely fixing a picture of a solid with both eyes doesn't by itself produce a stereoscopic effect, because of the absence of sense of difference of two retinal images. This last element is therefore important; but only in so far as it contributes to the principal factor, that of seeing a solid from two different aspects. Alone it is quite incapable of producing a stereoscopic effect.

If we hold the two stereoscopic pictures in front of the eyes, so that each eye is looking into the center of its picture and the visual axes are parallel, no stereoscopic effect will be obtained, even though each eye perceives a different image, the reason being that we are looking at both pictures from the same aspect (same plane). True, the pictures must be made to overlap, but not for the mere purpose of "uniting" them, that is incidental, but to give the eyes the sensation of looking at one thing from two different points.

Nevertheless, the fact that each eye perceives an image from its own point of view is a factor of some value in itself, since each image complementing the other produces a sense of completeness to which we are accustomed when looking at real solids with both eyes.

Powerful as the principal factor of stereoscopic vision is, it is not capable of producing a complete effect without the aid of shadows. A cube, the three presenting sides of which are equally illuminated, will lose a great part of its solid appearance. On the other hand, a picture of a cube drawn with one eye open, but properly shaded, does produce a strong stereoscopic effect. Suffice it furthermore to reflect, that solids do not appear flat, even if one does look at them with one eye; though to be sure, they lose much in "relief." Binocular vision, therefore, though important, is not essential for stereoscopic vision.

It is in monocular stereoscopic vision particularly, that the contributing effect of perspective vision is of value, since a sense of antero-posterior extension of an object can not fail to produce a sense of solidity.

Perspective vision. In examining the elements of perspective vision, it is obvious that the sense of play of the muscles of convergence is a powerful factor in producing a sense of depth, since the distances of objects correspond to the efforts of convergence; though it is to be remembered that beyond about twenty feet, it ceases to be of value (which incidentally applies to stereoscopic vision).

In the stereoscope, as well as in real life, it is the principal factor

of producing a complete sense of depth. Again, more so than in a case of stereoscopic vision, the author emphasizes that it is not the mere dissimilarity of the pictures that produces a sense of depth, but the *actual play of muscles of convergence that the stereoscope as well as conditions in real life require.*

It is almost unbelievable that "flat" pictures in the stereoscope, where all images arise from one plane, should require the convergence of the visual axes for various distances. It is, however, explained by the following: Because of each picture being taken from a different point of view, the objects in each picture are placed away from its outer field towards the center of binocular fixation (toward inner edge of picture). This relationship is strongest in the fore-ground of the picture, and is gradually reduced toward the back-ground, *i. e.,* objects in the fore-ground are displaced more toward the binocular center than those in the back-ground. The result is that the eyes actually converge more for objects that are supposed to be near than for objects that are supposed to be far, giving rise to a powerful sensation of depth.

Supporting proof is to be had in the following experiment: An ordinary stereoscopic card is cut so as to separate the two pictures. They are then approximated with their outer edges, so that they are reversed in relation to each other. Thus placed in the stereoscope, they are brought as near to the eyes as is comfortable. When thus used, a remarkable effect is obtained—the view is turned "inside out," *i. e.,* objects that should appear in the fore-ground appear in the back-ground and *vice versa.*

It may be necessary, Franklin says, to look for some time to get the effect, since the other factors of perspective vision militate against such an unnatural arrangement of things.

The explanation of this phenomenon is to be found in the fact that because of the reversed positions of the pictures, the displacement of near objects is toward the outer field instead of the inner field, with the result that the eyes converge less for objects in the fore-ground than for those in the back-ground; for which reason, what should appear near appears far, and *vice versa.* It is impossible, on the other hand, to see how the mere interchange of dissimilar pictures, *per se,* could produce such phenomenon. It appears to the author that the theory that "the perception of depth is caused by a slight non-identity of the two retinal images" is definitely disproven from the above consideration.

The play of the muscles of accommodation is next in importance. As in the case of convergence, the distance of objects corresponds

to the accommodative effort, though again beyond twenty feet it is of no value in judging distance. As already mentioned, it is a great aid to monocular stereoscopic vision. Let us bear in mind that even though we look at a series of solids with only one eye, we still have a strong sense of depth. Thanks to the play of accommodation and several other minor factors, we are able to get a fair sense of depth without binocular vision (convergence play).

The next subjective element in our sense of depth is blurring of a part of the field of vision (in an antero-posterior direction). Experience has taught us that when objects are blurred within twenty feet, it is either because they are in front of or beyond our point of convergence (doubling); or because they are in front or beyond our point of accommodation (out of focus). Ordinarily we are but vaguely aware of the condition, but nevertheless unconsciously, we are in part guided by it in projecting objects into their proper depth. The blurring of images because of increasing distance and because of atmospheric effects (decrease of air transparency, etc.), is of great value in perspective vision beyond the twenty feet limit.

It is common knowledge that we judge distance of objects by comparing their apparent size with what we consider their real size. And this is another useful factor in perspective vision beyond twenty feet. That to a certain extent we judge the relative position of objects as we are accustomed to find them, is perhaps not so generally suspected, but is nevertheless true. For example, a half mile away, we can not by our natural optical means really tell whether a tree is in front of a building or in its wall. Nevertheless, knowing from experience that trees grow in front of buildings and not in their walls, we are strongly under the impression that we really see it in front of the building.

Spearman (*Am. Journ. Ophthalm.*, p. 433, June, 1919) believes *stereoscopic vision* the most important factor in the *visual fitness of aviators,* especially in regard to successful landings, a source of much mortality among fliers. He divided his remarks into (1) a method of testing stereoscopic vision in candidates; (2) suggestions as to means of improving the vision of aviators.

This faculty had to be differentiated from quasistereopsis or the power of appreciating depth, which depended on the clues at the disposal of either eye alone. In stereoscopic vision, each eye had to form a good image, and that depended, principally, on the optical excellence of the iris. It seemed to be considered that for binocular vision all that was required was for both eyes to function, instead of only one. But there was only one visual field in consciousness, though there were two ocular fields: and both ocular and conscious fields

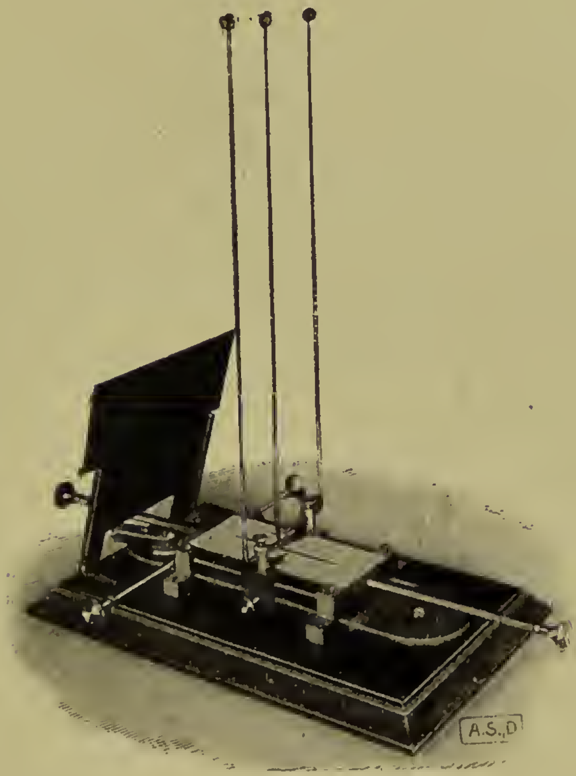
could not function with regard to the same spot at the same time. It was seldom that both eyes acted simultaneously: that was sometimes due to asymmetric astigmatism. It was important to try to find out how the ocular movements tested the balance of muscles. The eyes took up the right position for clear seeing if given plenty of time, but it did not necessarily follow they would do so when speed was essential. A test embracing the following of a moving field was therefore necessary.

See, also, several rubrics in **Physiological optics**; and under **Plastograph**; as well as **Stereoscope.**

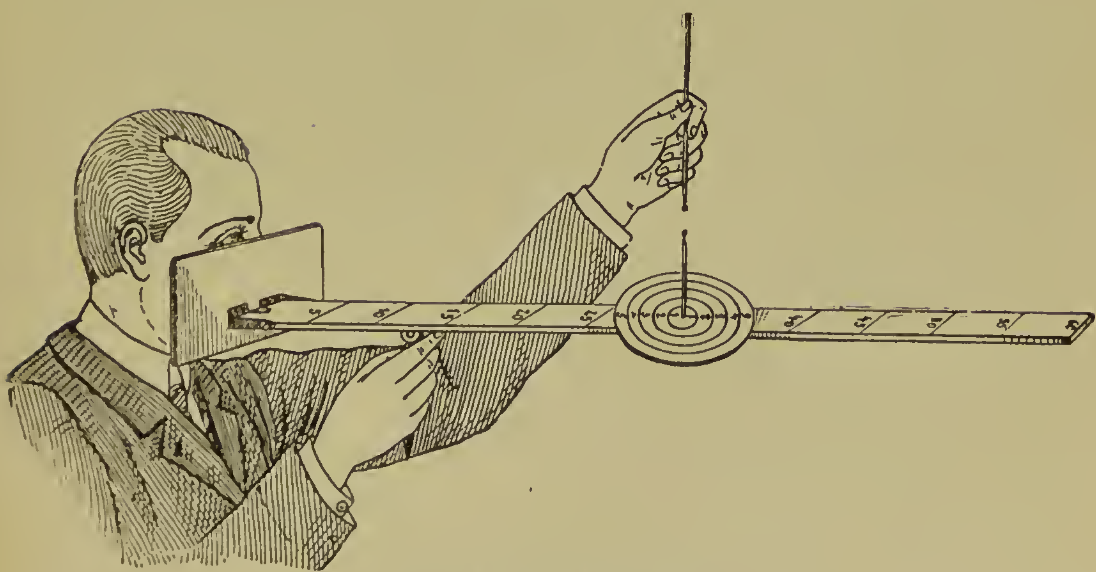
Stereoscoptometer. This instrument is employed to measure the power of estimating depth and the presence of binocular vision. Several appliances of the sort are known, among them the devices of Pfalz and that of Perlia. The latter is described by the inventor in the *Klin. Monatsbl. für Augenheilk.*, Oct., 1911. It is pictured in the text.

The patient holds the main apparatus with one hand, so that the upper margin of the screen hides the central rod, except its head. With the other hand the other rod is brought vertically down upon it as shown. Imperfect judgment of depth causes the one rod to miss the other, and the amount of the error may be read off from the circles about the base of the fixed rod.

Pfalz's stereoscoptometer is described on p. 9623, Vol. XII of this *Encyclopedia* and pictured in this text. On physiological grounds, the inventor criticizes (*Klin. Monatsbl. f. Augenheilk.*, Jan., 1912; review in *Ophthalmoscope*, Sept., 1914) the method advocated by Perlia for the measurement of perception of depth, by his simplified stereoscoptometer. He also holds that many of the reports given with regard to the faculty of space perception in injured workmen indicate that the examiners do not understand the physiology of the subject. Methods like the Hering drop test can only prove the presence or absence of the "binocular stereoscopic parallax," and cannot give a measurement of the faculty of depth perception. Moreover, they are of no use in a one-eyed man. Depth perception with two eyes involves the binocular stereoscopic parallax, and the muscular sensation associated with convergence and accommodation. Monocular depth perception depends on the monocular stereoscopic parallax, obtained by movements of the head, and the sensations resulting from convergence and accommodation. In a physiologically exact method there must be no change of the position of the fixation objects except in a direction to and from the eyes. Lateral movements, shadows, apparent changes in height with different distances, visibility of the mechanism, and all other aids, must be avoided. In the interests of exact and comparable



Pfalz's Stereoscope.



Perlia's Stereoscoptometer.

records, there must be standard size of fixation objects, standard positions of the objects as regards lateral separation and distance from the patient, and the objects must all be, and move, at the level of the eyes.

In Pfalz's stereoscoptometer three vertical rods, each tipped with a small ivory knob, are placed side by side at a definite distance from the eyes. The task of the examinee is to move the centre rod towards or from him, until the three are in line. A screen hides the mechanism from the patient. Pfalz enters on a detailed criticism of Perlia's instrument, the substance of which is that there are, in its use, too many inconstant factors, and that the patient has sources of information which vitiate the results. Moreover, he does not agree with Perlia's claim that his test enables him to examine blacksmiths and other workmen under conditions approaching those of their work. That can only be done by observing men under actual working conditions.

He gives some conclusions arrived at as the result of his researches, among which are the following.—With full vision in one eye and vision of 1/10 or even less in the other, binocular depth perception can be normal. Even considerable loss of sight in the better eye need not destroy it. Monocular perception of depth may be so perfect as to satisfy the demands of any occupation. With his instrument, if no greater error is made than ½ c.m. he considers the result perfect. If a one-eyed man, from 35 to 40 years of age, resumes his former occupation, he recovers his working capacity fully in from six months to one year. If he is over 40 at the date of his loss, it may require two years.

Perlia (*Klin. Monatsbl. f. Augenheilk.*, May, 1912) replied to these criticisms. He maintains that his method is superior to those of Pfalz and others, since it tests the patient's space perception under conditions as nearly as possible approaching to those of practical life. It ascertains (1) the patient's power of estimating the relative positions of several points, and (2) the power of projecting objects to their proper positions in space. The second is found by causing the patient to strike a small object, in a way which closely imitates a number of actions which involve reflex association of hand and eye.

Wolff (*Zeitschr. f. Augenheilk.*, p. 405, 1911) has modified Pfalz's instrument and produced what seems a more serviceable apparatus.

The three little rods can be placed in any of the nine holes, and the box held up before the patient at a distance of 40 cm., with the screen towards him, hiding the rods except their heads. He is then required to tell which is the nearest and which the farthest from him. See p. 11460, Vol. XV of this *Encyclopedia.*

Stereosol. This is a kind of antiseptic varnish advocated by Domec (*Oph. Year-Book*, p. 47, 1912). It is made of: Purified gum-lac completely soluble in alcohol, 270 gms.; purified benzoin completely soluble in alcohol, 10 gms.; balsam of tolu, 10 gms.; crystallized carbolic acid, 100 gms.; essence of Chinese cinnamon, 6 gms.; saccharin, 6 gms.; alcohol 90 per cent. to make a litre of liquid, q.s. gms.

It is applied by everting the lid and holding it exposed until all smarting has ceased, after which the eye should be kept closed for five or ten minutes. The application is made daily. In granular, follicular and vernal conjunctivitis, and in septic corneal ulcers his results have been satisfactory; but not in serpent ulcer.

Stereoskiagraphy. The making of a stereoscopic photograph by the Röntgen rays.

Stereotelemeter. See the beginning of the section **Stereoscope.**

Stereotelescope. A binocular telescope in which the inter-objective distance is greater than the interocular.

Stereotomy. The science or art of cutting solid bodies into sections.

Stereotrope. A stereoscopic thaumatrope.

Stereotypemaker. An appliance for making embossed books for the blind. See **Alphabets and literature for the blind.**

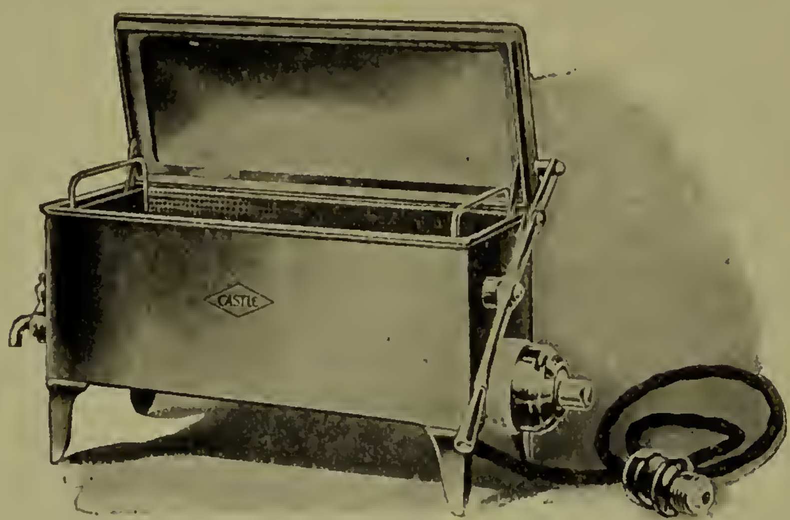
Sterilization. This subject has been considered under several headings in this *Encyclopedia*, notably on p. 10349, Vol. XIII, and on p. 6042, Vol. VIII. To the matter there found may be added the following items:

To sterilize the lashes Pflugk (*Oph. Year-Book*, p. 326, 1909) has used benzine. After washing with soap and water, the surface is covered with gauze, leaving exposed a strip one centimeter on each side of the palpebral fissure. The lashes and adjoining skin are then scrubbed with sterile cotton, on which has been placed about 20 drops of benzine. The eye is then covered with cotton, soaked in salt solution, until the operation is to be commenced. Only pure benzine is used. It causes a slight burning for a few minutes; but in 2,000 cases it caused no inflammation, or other bad effect. Pflugk believes that it acts by removing the grease, in which the bacteria are adherent to the lashes. Of 26 lashes tested after such treatment 25 were found sterile.

Dor calls attention to the method in common use among bacteriologists for *sterilizing instruments* in hot oil. They can in this way be raised to a temperature of 140° Cent. or upward. He states that treated by this method the instruments remain indefinitely new. The cutting edges and points are not altered; and the oil is distinctly superior to solutions of borax. Vacher has described a method of placing instruments in sealed tubes of boric solution, sterilizing in the autoclave and keeping them in the tubes until needed for use.

Conradi (*Prac. Med. Series,* p. 51, 1910) does not believe that boiling in 1 per cent. solution of soda absolutely sterilizes instruments. There are ubiquitous bacilli, bacillus vulgatus and mesentericus, whose spores do not perish in boiling water. Absolute sterilization is obtained in Jaffa sesam-oil, which in a few minutes can be heated to 200° C., and more, a temperature that surely destroys all known producers of spores. As the boiling point of the oil lies between 310° and 320° C., there is very little waste connected with this method. It is also recommended for the sterilization of bougies and catheters.

Sterilizers for ophthalmic use. Although the autoclave or sterilizer used in general surgery may be employed for ophthalmic instruments and dressings, yet devices especially adapted to the smaller and gen-



Electric Instrument Sterilizer.

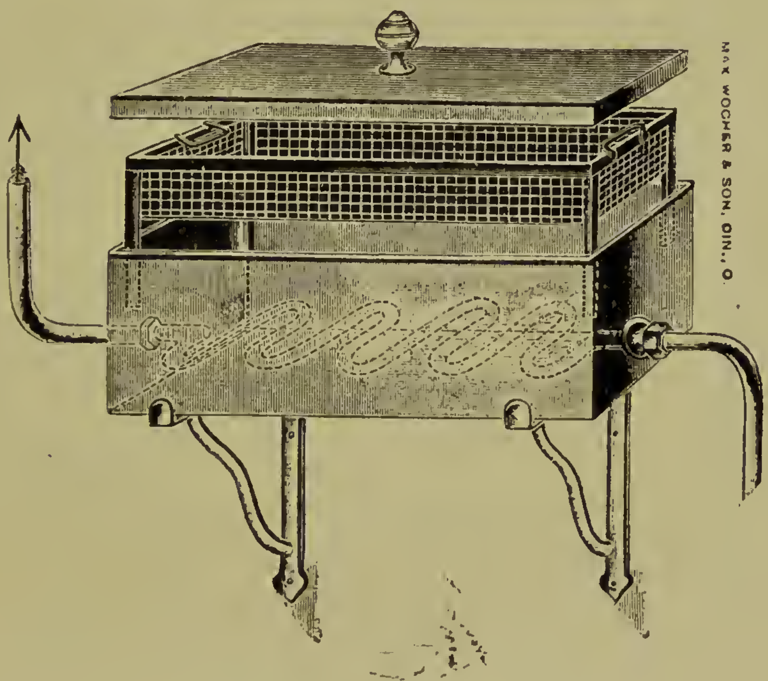
erally more delicate armamentarium of the eye surgeon are mostly to be preferred. Many of these are described and depicted on p. 6042, Vol. VIII, and elsewhere, in this *Encyclopedia.* Others are indicated in this section.

As all ophthalmologists know, it is difficult to keep the edges and points in perfect condition on such delicate instruments as Graefe cataract knives and angular keratomes. In the process of sterilization the assistant or nurse is apt to allow them to strike the other instruments. Carrying in the case will sometimes permit them to slip forward, and in a multitude of ways their perfectness of finish is endangered. To protect them F. Park Lewis (*Ophthal. Rec.,* March, 1914) has devised shields into which the instruments slip and in which they may be left when carried in the case and through the process of sterilization. These will also protect the instrument from contamination

after being sterilized. The shields are very simple and light, being made of aluminum and scarcely appreciably add to the weight and bulk of the instrument.

The *electric instrument sterilizer* shown in the accompanying figure is made of heavy copper, nickel-plated, for use on the 104 to 110 volt electric current; size 6½ inches wide by 13 inches long.

The so-called *hospital sterilizer* is designed for hospitals having steam pressure. It has a steam coil as shown, or can be made for gas. It is supplied with wall brackets or white enameled floor stand. Size, 7 inches deep, 9 inches wide, and 20 inches long.

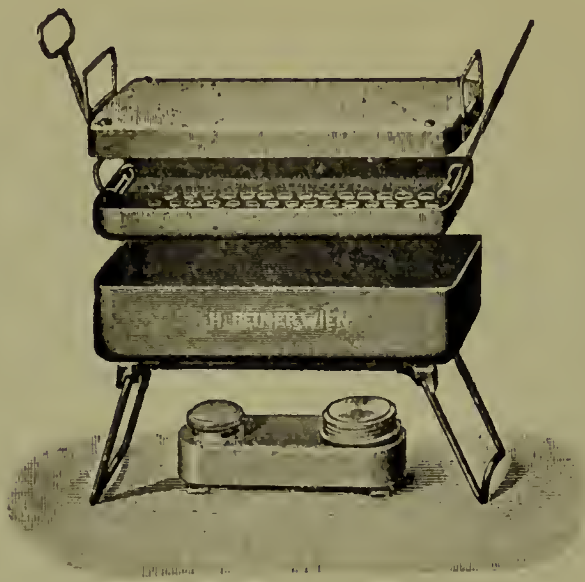


Hospital Instrument Sterilizer.

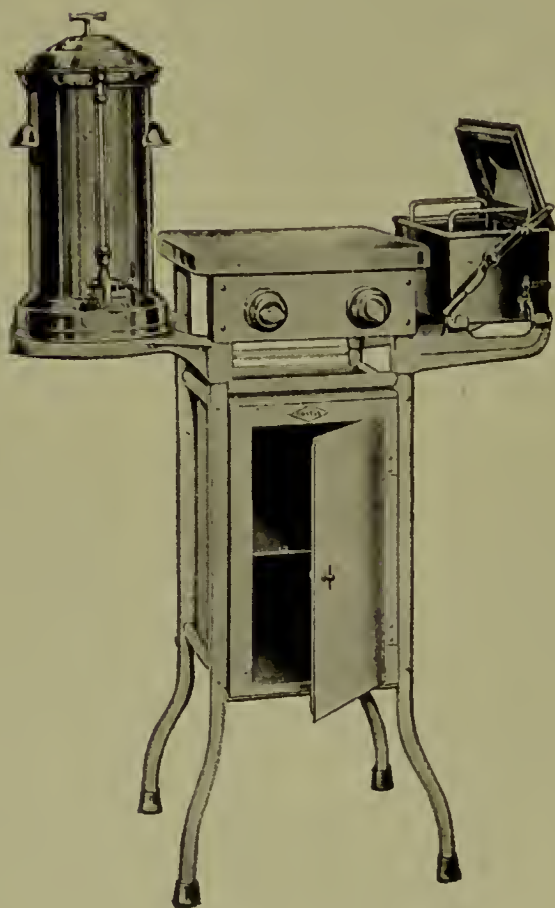
The *Schimmelbusch sterilizer* (see the figure) is 188 mm. long, 80 mm. broad and 40 mm. high; the heat is supplied by a spirit lamp.

The *Wilmot Castle Co.* sterilizers of Rochester, N. Y., are well adapted for both hospital and office practice. They may be used with other heating agents (gas or alcohol lamps) but electricity is preferred. See the illustrations.

A *complete sterilizing outfit for office or small hospital* is depicted in this text. It provides sterile hot and cold water and the heating may be arranged for either gas, gasoline, alcohol, steam or electricity. It has adequate facilities for sterilizing all instruments. Dressings, bandages and gowns are sterilized by live steam which is forced through them in such a way as to insure absolute penetration. Hot air heats and dries dressings before and after sterilization, but no



Schimmelbusch's Sterilizer.

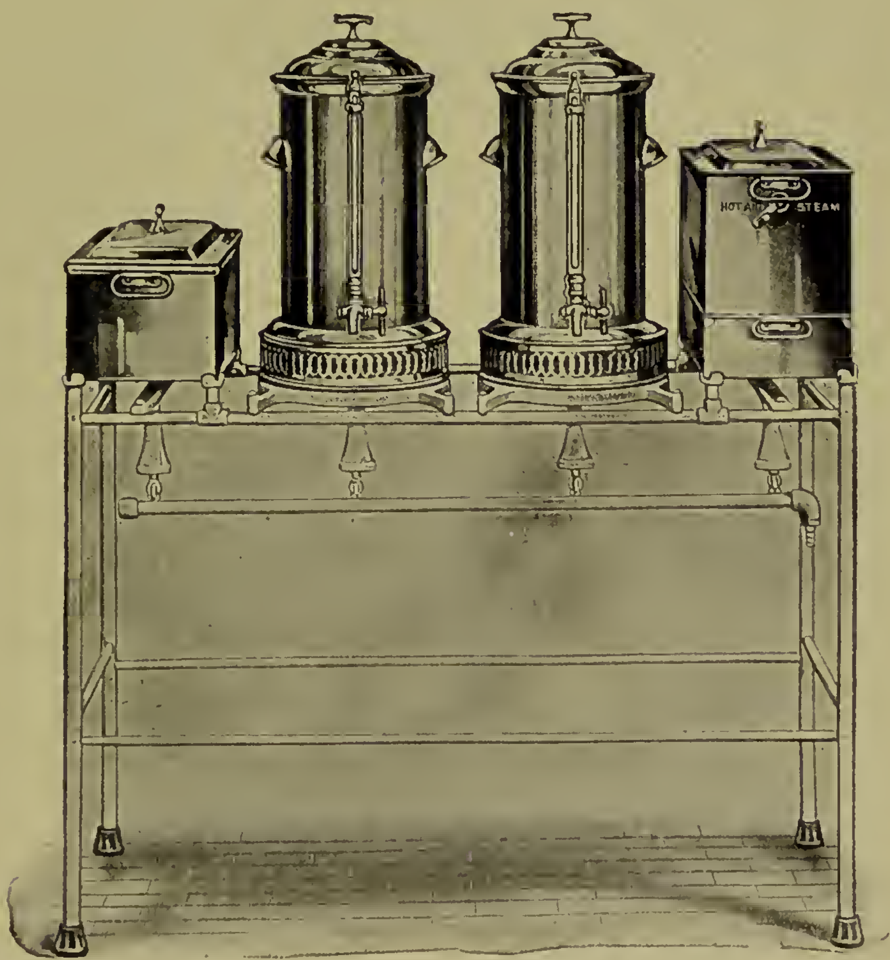


Instrument and Water Sterilizer.

Instrument and water sterilizers mounted on a special table for office use, and electrically heated, are shown in the text. It may be provided, also, for gas, alcohol or gasoline.

products of combustion ever enter the sterilizing chamber. A single valve controls the steam and hot air.

There are instrument and dressing sterilizers furnished with trays for handling the contents. Water sterilizers are each equipped with protected water gauge and three-way draw-off faucet. Heavy cold-rolled copper is used in construction of this sterilizer; exteriors nickel-



Wilmot Castle Sterilizer for Ophthalmic Surgeons.

plated and highly polished; interiors coated with pure tin. Stand is made of tubular steel, finished in polished white enamel.

A convenient *sterilizer, suitable for office work and heated by electricity* is shown in the text. As pointed out by the makers the cover is opened and the tray with instruments lifted out of the boiling water by simply pushing down a cool lever. You can use your hand or forearm. The tray stays up so that the instruments drain and cool before they are taken from the sterilizer. Sharp instruments may be laid in the tray, then slowly immersed in the water without injuring

their cutting edges. Economical operation of the sterilizer is made possible by having three heats. The "high" heat—which draws the most current—is only used to bring the water to the boiling point quickly. The heat control switch—right on the sterilizer—has an indicating dial which shows whether "high," "medium" or "low" is turned on. There is no fussing with plugs. The sterilizer will not burn out nor can the instruments be injured by overheating. Attached to the electric unit is a safety device that automatically shuts off the current when the water in the sterilizer becomes very low. There is a faucet to draw off the water which eliminates the necessity of disconnecting and carrying the sterilizer to a sink each time it is emptied.

The sterilizer is made of extra heavy copper coated inside with pure tin. Lifting lever and legs are cast brass. All parts are beautifully nickel-plated. Supplied complete with six feet of cord and connecting plug.

Sternstaar. (G.) Stellate cataract.

Sterules. These are glass capsules filled with sterile solutions for ophthalmic and general use, chiefly in Great Britain. The sterule (ophthalmic) is inserted through an ejector, and its breech end is snapped off at the file mark. It is drawn farther through the ejector, held horizontally, and the other end is broken off at the file mark. The breech end of the ejector is now covered with the index finger, and the soft part is pressed with the thumb and second finger to release a small quantity (sufficient for one application in eye work) of a sterile solution. The file marks are situated one-fourth inch from the ends of the "sterule."

Stevens' clinoscope. See **Clinoscope, Stevens'**, p. 2294, Vol. III of this *Encyclopedia.*

Stevens, Edmund W. A Canadian-American ophthalmologist, of much promise, who died in middle life. Born at Woodstock, N. B., in 1864, he received his medical degree from Jefferson Medical College in 1884. At first he practised general medicine in New Brunswick, but, being in feeble health, and unable to stand the rigors of the Canadian climate, he removed to Philadelphia. He was there for a time demonstrator of anatomy in the Pennsylvania College of Dental Surgery, but, acquiring soon an interest in ophthalmology, he took up the study of that specialty at the Philadelphia Polyclinic, Jefferson Medical College, and Wills Eye Hospital.

In 1898 he was obliged to remove to Colorado because of a continually increasing pulmonary disease. One year later, he began to practise ophthalmology at Denver, and he kept at work, with now and then a brief interval of rest, until his death. Oct. 30, 1910.

According to Edward Jackson, "Both in his writings and in his part in medical society discussion, Dr. Stevens exhibited accurate knowledge and a talent for clear, condensed statement. His sound judgment and conservatism made him a valued consultant. . . . Always handicapped by poor health, he yet accomplished as many days' work each year as most of his colleagues, and achieved a high place in the esteem of his neighbors in the medical profession."

Stevens' ophthalmologic writings are as follows: 1. Section on the Use of the Ophthalmometer, in de Schweinitz's *Diseases of the Eye.* 2. Extirpation of the Lacrimal Sac for Dacryocystitis. (*Colorado Medicine,* 1904, p. 261.) 3. Fatal Septicemia Due to Ophthalmia Neonatorum. (*Ophthalmic Record,* 1905, p. 519.) 4. Retinal Hemorrhage in Apparently Healthy Eyes. (*Colorado Medicine,* 1906, p. 176.) 5. Emphysema of Orbit and Lids Following Removal of Middle Turbinate. (*Denver Medical Times,* Nov., 1907, p. 157.) 6. Direct Injury to Optic Nerve. (*Colorado Medicine,* 1908, p. 269.)—(T. H. S.)

Stevens' method of tenotomy. See p. 8196, Vol. XI of this *Encyclopedia.*

Stevenson, John. An English ophthalmologist, of no very great ability. Born about 1780, he studied with Saunders and settled in London. He became an M. R. C. S., as well as surgeon and ophthalmologist to the Duke of York. He founded in London a "Dispensary for Cataractous Patients," whose name, in 1823, was changed to "Ophthalmic Institute for the Cure of Cataract." In 1841 he became ophthalmologist and aural physician to the King of Belgium. He was for a time instructor in the anatomy, physiology and pathology of the eye and ear. He lived in Margaret Street, Cavendish Square, but nothing is known concerning his life subsequent to 1844.

Stevenson's ophthalmological writings are as follows: 1. *On the Morbid Sensibility of the Eye, Commonly Called Weakness of Sight.* (London, 1810.) 2. Letter (on Cataract) to the Editors of the *Medical and Physical Journal.* (Vol. XXVIII, pp. 257-265, and 357-367.) 3. *A Practical Treatise on Cataract.* (London, 1813.) 4. *On the Nature and Symptoms of Cataract and on the Cure of that Disease in its Early Stages.* (London, 1824.) 5. *On the Nature, Symptoms and Treatment of the Different Species of Amaurosis or Gutta Serena.* (London, 1821.) 6. *On the Advantage of an Early Operation for the Different Forms of Cataract.* (*Edinburgh Jour.,* XIX, pp. 513-524, 1823.) 7. *Cataract, a Familiar Description of its Nature, Symptoms and Ordinary Modes of Treatment.* (London, 1834.)—(T. H. S.)

Stevenson, Mark Delimon. An ophthalmologist of great promise, who died before he had reached his prime. Born at Trafalgar, Ontario,

Canada, in 1876, he received his medical degree at Rush Medical College, Chicago, in 1897. After a course at the Royal London Ophthalmic Hospital, he settled, in 1900, at Akron, Ohio, where he practised until his death.

For ten years he was associated in practice with Dr. E. M. Weaver.

Mark Stevenson was ophthalmic surgeon to the Akron City Hospital, and to the People's Hospital; also oculist and aurist to the Children's Hospital. In 1911 he established, on East Market Street, Akron, a private hospital, which he conducted with great success until his death.

He was a member of the American Medical Association, and a Fellow of the American College of Surgeons. A frequent contributor to medical journals and the inventor of several useful ophthalmic instruments, he was also one of the collaborators on *"Ophthalmology."*

He married, in January, 1915, Miss Martha von Novelley, of Vienna, daughter of a famous Austrian civil engineer.

Dr. Stevenson came to his death very unexpectedly. While he was preparing to perform an operation, he sent the nail file too deeply beneath his left thumb nail. During the subsequent operation the tiny scratch became infected, and, though all was done that lay in human power to save his life he died of septicemia, May 22, 1915, aged only 39.—(T. H. S.)

Stevens' phorometer. See p. 9649, Vol. XIII of this *Encyclopedia.*

Stevens' tropometer. See p. 7984, Vol. X of this *Encyclopedia.*

Stewart, Andrew J. A well-known western ophthalmologist. He was born at Provo City, Utah, April 10, 1873, the oldest son of Andrew J., and Melissa Riggs, Stewart. For a time he was a government surveyor, then school-teacher, and, at length, a missionary to Germany from the church of Jesus Christ of Latter-day Saints. He graduated from the business department of Brigham Young University in 1895, and, in 1900, from the normal department. Entering at once the College of Physicians and Surgeons at Baltimore, he there received his medical degree in 1904. At some time in the course of these four years, he married Miss Rose Young, of Provo City.

For a time he practised in Mt. Pleasant, Utah, but later removed to Provo, where he remained until his death. At just what time he began to devote himself to ophthalmology could not be learned. At the time of his death he was president of the Utah County Medical Association.

Dr. Stewart died at his home in Provo, of broncho-pneumonia, on May 25, 1919.—(T. H. S.)

Stewart, John S. An American ophthalmologist of much promise who died young. Born in Allegheny County, Pennsylvania, Nov. 19, 1864, he received his liberal education at the Western University, and his medical training at the Medico-Chirurgical College of Philadelphia. At the latter institution he was graduated in 1885, with the highest honors. He settled as ophthalmologist in Philadelphia, wrote a number of ophthalmologic articles, and died of tuberculosis April 11, 1892, having been a practitioner only about seven years.—(T. H. S.)

Sticks. See **Pencils,** p. 9413, Vol. XII of this *Encyclopedia.*

Stieda's grooves. The small sulci about the so-called papillary bodies of Eble in the palpebral conjunctiva.

Stieräugig. (G.) Affected with buphthalmia.

Stiffened sclera. See **Sclera, Stiffened.**

Stigmatic. Bringing to a point.

Stigmatometer. An instrument for testing the refraction of the eye by the objective method and for direct ophthalmoscopy; a form of ophthalmometer.

Stigmometric test. See p. 4641, Vol. VI of this *Encyclopedia.* Fridenberg's stigmometric test type is a series of dots, definitely gradu-

Fridenberg's Stigmometric Test.

ated, to be counted by the patient at various reading distances as a test of accommodation and vision in illiterates. See the illustration.

Stillicidium. 1. A dribbling or flowing by drops. 2. Epiphora.

Stillicidium lacrimale. STILLICIDIUM LACRIMARUM. EPIPHORA. The watery eye; a more or less constant overflow of tears upon the cheeks, due to eversion, tumefaction or narrowing of the puncta lacrimalia, or to stoppage of the nasal duct.

Stilling, Benedict. A famous German anatomist, surgeon and ophthalmologist. Born at the village of Kirchhain, in the Electorate of Hesse, Feb. 22, 1810, the son of a dealer in wool, he received his medical degree at Marburg, in 1832. His dissertation on this occasion was "De Pupilla Artificiale in Sclerotica Conformanda." In 1833 he was made assistant at Ullman's Surgical Hospital, but, before the end of the year, removed to Cassel, in order to accept the appointment of surgeon to the Landesgericht. Seven years later he resigned the position, but continued to practise in Cassel. Meantime (in 1836) he had made a trip to Paris, for the purpose of studying with Magendie and Amussat. He also studied, at various times, in Italy, Paris, London, Edinburgh and Vienna. According to Pagel, he was for many years the only person in Germany who performed ovariotomies. For a short time, Stilling was Privy Sanitary Councillor. He died at Cassel, Jan. 28, 1879.

Stilling's investigation into the "Architektonik" of the central nervous system yielded revolutionary results, and the most important of his writings have reference to that anatomical subject. In ophthalmology his writings are as follows: 1. De Pupilla Artificiale in Sclerotica Conformanda. (Marburg, 1833. The graduation dissertation above referred to. In this dissertation Stilling describes the first (his own) successful attempt at the transplantation of corneal tissue into an opening in the sclera. Dieffenbach had, in 1830, made the same attempt, but without success. Stilling performed his experiment on the rabbit. The transplanted cornea not only grew tight to its position, but remained transparent. Lymph effused into the vitreous, however, just below this little artificial window, and thus effectually prevented a view from being obtained there through into the ocular interior.) 2. Blindheit in Folge einer die Schnerven Comprimierenden Geschwulst. (von Ammon's *Z. f. Oph.*, III, p. 465, 1833.) 3. Cilien im Auge. (Holscher's *Annalen*, 1839.) 4. Ein Wort über Angeborene Spaltungen in der Iris, Iridoschisma, Coloboma Iridis. (Holscher's *Hannoversche Annalen*, 1837.)—(T. H. S.)

Stilling, Canal of. Another name for the canal of Cloquet (q. v.), or hyaloid canal. See p. 1376, Vol. II of this *Encyclopedia*.

Stilling's color-test plates. These charts have been described on p. 2457, Vol. IV and on p. 5100, Vol. VII of this *Encyclopedia*. Geo.

H. Taylor (*Ophthalmology,* Oct., 1914, and *Ophthalmoscope,* p. 128, March, 1915) thinks Stilling's plates the *best* single color-vision test we have. He tabulates the results of the examination of 200 consecutive cases by this test, comparing the results with those obtained by Holmgren's wools, Williams' lantern, and Nagel's anomaloscope; and thinks they should replace Holmgren's wools for testing employees of railways, and be used in conjunction with the modified Williams' lantern.

Stilling's naso-lachrymal knife. Stilling modeled the triangular bladed instrument bearing his name after a French knife for incising urethral strictures. It tapered from 0.75 mm. to 3 mm. in breadth, and had a single, rounded cutting edge. The exact locality of the stricture having been determined the knife was introduced in the usual manner and the stricture cut through in various directions by alternate (partial) withdrawals and introductions of the blade.

Stimulus, Minimum, of the retina. Physiologists, by comparing the visual sensations caused by different degrees of luminosity, have found that, within certain limits, the smallest difference of light which the human eye can appreciate is about $\frac{1}{100}$ of the total luminosity.

The time necessary for excitation of the retina by light is exceedingly small. It has been computed that light thrown from a rotating mirror stimulates the eye when acting for only $\frac{1}{8\,000\,000}$ part of a second.—(J. M. B.)

Stirnhöhle. (G.) Frontal sinus.

Stitch. See **Suture.**

Stitch or suture scissors. This valuable aid in many ophthalmic procedures, but especially in strabismus operations, has already been several times mentioned in this work. See, also, **Scissors.**

St. John, Samuel Benedict. A well known ophthalmologist of Hartford, Conn. Born at Hudson, Ohio, July 24, 1845, the son of Dr. Samuel St. John, a professor in Western Reserve College of Ohio, he received the degree of A. B. at Yale University in 1866, and that of M. D. at the College of Physicians and Surgeons in the City of New York in 1870. For a year he served on the house staff at the Bellevue Hospital, and then became first house surgeon at the Manhattan Eye and Ear Hospital. For a time he was assistant demonstrator of anatomy and instructor in chemistry at the College of Physicians and Surgeons. From 1872-'74 he studied ophthalmology in Berlin, Vienna, Paris and London. In 1876 he became assistant surgeon in the Ophthalmic Department of the New York Eye and Ear Infirmary. In 1878 he settled as ophthalmologist and otologist at Hartford, Conn., where he practised for thirty-one years, i. e., until his death. In 1882

he was made instructor in ophthalmology at the Yale Medical School, a position which he held for twenty-three years. He was secretary of the American Ophthalmological Society from 1888 till 1908, and its president in 1908 and 1909. In 1909 he was elected a delegate to the International Ophthalmological Congress, which met at Naples. He married in 1882 Miss Mary Harris Morgan, by whom he had two daughters. He died of angina pectoris Dec. 21, 1909.

Dr. St. John was a man of very quiet manner, modest and unassuming. He was public-spirited, and held a number of local offices of financially unremunerative character, to all of which he gave most freely both of his time and of his work.—(T. H. S.)

Stoco lens. This is a patented centering and axis finding device.

Stoeber, Victor. A distinguished French professor of ophthalmology, founder of the first ophthalmic hospital in France. Born at Strass-

Victor Stoeber.

burg, in Alsace, Feb. 13, 1803, he received his medical degree in the same city in 1824. He then pursued the study of ophthalmology in Paris, London, Dublin, Glasgow, Edinburgh, and in Holland, Belgium and Italy. In 1829 he was made adjunct professor at the University of Strassburg, and in 1830 he began to lecture on ophthalmology, also publishing his *"Manuel Pratique d'Ophthalmologie ou Traité des*

Maladies des Yeux" (Paris and Strassburg, 1830; 2d ed., Brussels, 1837). This work is declared by Gurlt to be "the most complete handbook on the subject at that time in the French language." In 1845 he founded the above-mentioned eye hospital. At its beginning, this institution had only ten beds, but it rapidly grew both in size and in usefulness.

Stoeber was twice married, his first wife dying after a union of fourteen years. The second wife died soon after she had borne him a son.

In 1866 Stoeber began to suffer from a painful affection of the bladder. Nevertheless, at the siege of Paris, he was actively on duty among the sick and wounded. He died June 5, 1871.

He wrote no other book of an ophthalmologic character than that above mentioned, but his articles in journals, especially in the "*Annales d'Oculistique,*" are very numerous, and relate to almost every branch and phase of ophthalmology.—(T. H. S.)

Stokes' lens. A device consisting of two plano-cylindrical lenses of equal focal distance, employed in the diagnosis of astigmatism. See p. 7195, Vol. X of this *Encyclopedia*.

Stokes, The Rev. Edward. An Anglican clergyman and philanthropist, who, from the age of 9 until his death, was totally blind. He was born in 1705. His blindness resulted from a pistol wound, given him accidentally by a brother. He attended Oxford University, at which institution he received the degree of Master of Arts. He then took holy orders, and began to preach in Leicestershire about 1730. Here he continued in the service of the church until his death, 66 years later. A wealthy man in early life, he died poor, having expended among the needy the whole of a very large fortune.—(T. H. S.)

Stoma. A small opening or orifice onto a free surface.

Stone, Elise Pfeiffer. A medical practitioner of Oakland, Calif., whose practice was almost wholly limited to ophthalmology and otology. Elise Pfeiffer was born in Mainz, Germany, in 1819. Having studied medicine at the University of Giessen for three years, she removed to New York, where she practised general medicine until 1857, when she married a Mr. George Stone, and changed her residence to Nevada City, California. Six years later she removed to San Francisco, and again began to practise. In 1867 she was graduated from the Woman's Medical College of Philadelphia, and four years later located in Oakland, where she practised general medicine, but especially ophthalmology and otology, until her death. She died at her home in Oakland, May 30, 1880.—(T. H. S.)

Stone, Robert King. A well known American anatomist, physiologist, and ophthalmologist. Born in 1822 at Washington, D. C., of old

American ancestry, he received the degree of A. B. at Princeton University. For a time he studied medicine under Dr. Thomas Miller, of Washington, and then attended lectures at both the National Medical College, District of Columbia, and the University of Pennsylvania. At the latter institution he received his degree in 1848. In 1849 he received the degree of M. D. *ad eundem* at the University of Louisville, and again, in 1851, at the University of New York. For a number of years he studied in London, Edinburgh, Vienna, and Paris, paying especial attention to anatomy, physiology, and ophthalmology.

He settled in Washington in 1847 as general practitioner, and was shortly afterward made assistant to the professor of anatomy in the National Medical College. In 1848 he was adjunct professor of anatomy and physiology at the same institution, and a few years later full professor of anatomy, physiology, microscopic anatomy, and ophthalmic and aural surgery. Being thrown from his carriage, he suffered a fracture of the thigh, and was never well afterwards. He resigned his teaching positions, and, for a time, restricted his practise to ophthalmology and otology. He died suddenly, of apoplexy, at Philadelphia, April 23, 1872.—(T. H. S.)

Stony cataract. A degenerated cataract, which has become of an intense hardness.

Stop. A perforated screen inserted in the field of view to cut off the marginal rays of a lens, and thus to obviate or limit spherical aberration.

Stop needle. Used mostly for discission of cataract. See p. 8292, Vol. XI of this *Encyclopedia*.

Stork, The. In ancient Greco-Roman times a young stork was eaten by way of prophylaxis against lippitudo.—(T. H. S.)

Stovain. The hydrochlorid of benzoylethyldimethylaminopropanol, $CH_3C(C_2H_5)\ (OC_7H_5O)\ CH_2N(CH_3)_2HCl$; a crystalline compound: used as a local anesthetic, especially for subcutaneous and subconjunctival use. It is much less toxic than cocain. Dose of 1 per cent. solution, $\frac{1}{30}$ min. (0.002c.c.) For ophthalmic work it is often combined with eucain, as a substitute for cocain.

This complicated organic compound occurs as small, brilliant, crystalline scales that melt at 347° F. (175° C.) and are very soluble in water. It is quite stable and its solution may be sterilized at 115° C. without decomposition.

Of the substitutes for cocain as a local anesthetic this agent comes to us highly recommended, especially by Santos Fernandez. Its use should be limited to subconjunctival and subcutaneous injections as in instillations it is not as effective as cocain. It is less than half as

toxic as cocain. On account of its vaso-dilating property it should always be preferred to cocain in injections, as the latter, a vaso-constrictor, even though used cautiously, may produce precordial anxiety and pallor of the face, against which one is completely guarded if stovain is employed. One may operate while the patient is sitting upright without fear of synocope. It is commonly used in the eye as instillations in four per cent. solution; for hypodermic or subconjunctival purposes in 0.75 to 1 per cent. aqueous solution.

Darier (*Thérapeutique Oculaire,* p. 86) believes that this agent is but slightly toxic and when given hypodermically does not act as a depressant. On the contrary it is a heart tonic, augmenting the intensity of its contraction. As a local anesthetic it is, perhaps, in equal dose, less effective than cocain; but in anesthesia by infiltration, the latter agent might easily be discarded for the same percentage of stovain. It is also a decided antiseptic.

The instillation of stovain solutions is more painful than that of cocain. Darier uses with the very best results a mixture of equal parts of acoin, stovain and cocain, both for operation on the eye and for other purposes. He finds that corneal anesthesia is brought about most rapidly by the following mixture: Adrenalin hydrochlor. 1:1000, gtt. x; Stovain., Cocain. hydrochlor. āā. 0.10; Sol. sodii chlor, (1 per cent.) 5.00.

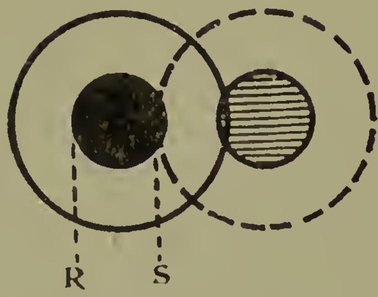
Darier believes it to equal cocain as a local anesthetic and advises its use in 2 to 4 per cent. solutions, which when boiled retain their power. It has a disagreeable odor, a bitter taste and is a feebler mydriatic and cycloplegic than cocain. Like alypin (q. v.) it is a vasodilator. It acts as a decided irritant when combined with adrenalin in hypodermic or subconjunctival injections. See, also, **Rachistovainization.**

Strabilismus. Strabismus. Squint.

Strabismal. Strabismic. Strabismical. Pertaining to, affected by, or involving strabismus.

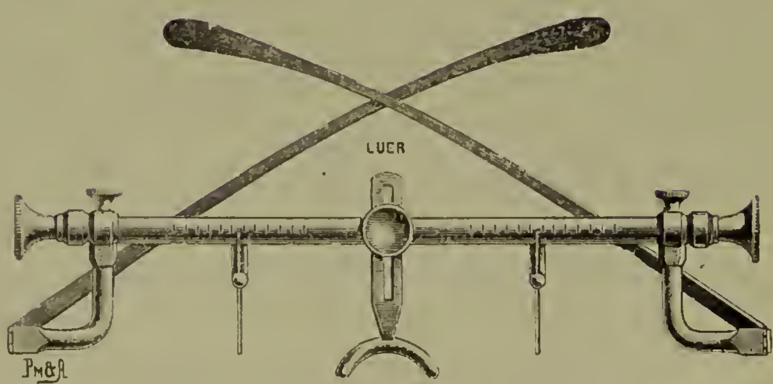
Strabismometry. The art and science of measuring and recording the character and amount of squint.

Strabismometer. Strabisometer. Strabometer. An instrument for the linear measurement of the amount and degree of deviation from the normal position in a squinting eye. Instruments of this character are among the earliest devices for recording the amount of squint. The simplest, oldest and best known strabismometer (that of Lawrence) is figured in the text. In using this form the patient looks at a distant object while the surgeon makes on the lower lid a vertical mark corresponding to the outer margin of the cornea of the squinting



Linear Measurement of Strabismus. (Ball.)

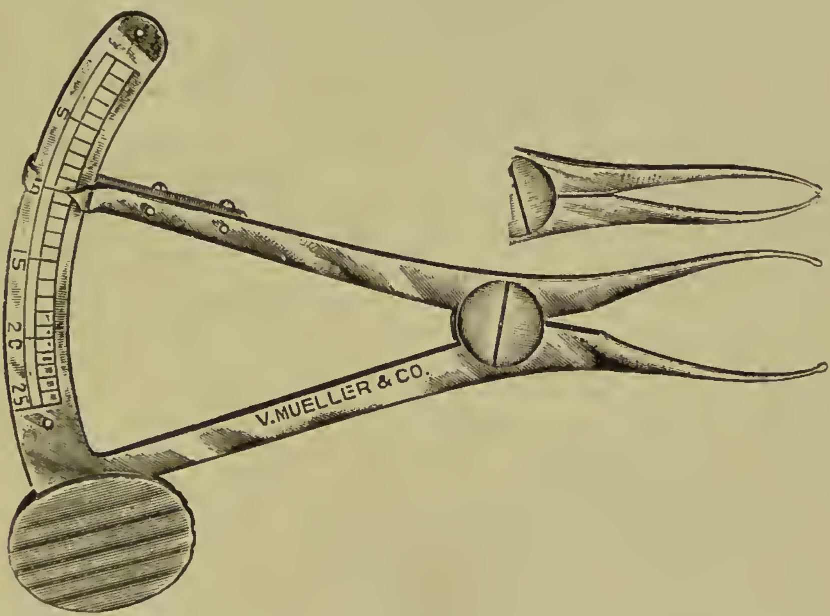
Lawrence's Strabometer.



Galezowski's Binocular Strabometer.

eye. Then the normal eye is covered and the patient looks at the same object while the surgeon again marks the outer margin of the cornea. The distance between these marks (distance from S to R in the figure) is measured in millimetres and recorded.—(J. M. B.)

Galezowski's strabismometer consists of a graduated horizontal bar, on which slide two needles which, when placed opposite the centres of the cornea, indicate by means of a scale on the bar the degree of deviation. The transverse bar is held on a level with the eyelids, the handle of the instrument upward and the fork of the bar against the root of the nose. See the figure. See, also p. 8106, Vol. XI of this *Encyclopedia*.



Woodruff's Automatic Strabometer for Measuring the Degrees of Strabismus.

Woodruff's automatic strabometer (new model) for measuring the degrees of strabismus, is a useful appliance whose method of employment is readily understood by a glance at the illustration.

de Wecker and Masselon devised a *hand perimeter strabometer* which is very useful for work in hospital wards and for bed-ridden patients.

For further consideration of *strabometry* see p. 8106, Vol. XI of this *Encyclopedia*.

Strabismus. Squint in general. This most important subject has already been fully discussed in most of its aspects under **Muscles, Ocular,** Vols. X and XI; under **Examination of the eye,** p. 4680, Vol. VI, as well as under many such minor headings as **Convergent squint,** p. 3297, Vol. V; **Divergence** and **Divergent squint,** pp. 4051,

4052, Vol. VI; **Stereoscope; Amblyoscope,** p. 306, Vol. I; **Buffon's strabismus theory,** p. 1324, Vol. II of this *Encyclopedia*. To the matter there arranged (and to which the reader is referred) the following observations are now added.

Colored glasses in intermittent squint. Poullain (*Rec. d'Ophtalm.*, Apr., 1908; abs. *Oph. Rec.*, Nov., 1908) remarks that in cases of intermittent strabismus generally the patients are young, there is perfect visual acuity in each eye, the eyes may be a trifle hypermetropic or may be emmetropic, the stereoscopic examination is passed with ease, but the parents of the young patients assert that when they are tired, or excited, one or other eye diverges. In such cases Javal was wont to order a shade to be worn over each eye alternately for some time daily.

Poullain has attempted to correct the tendency to this squint, and the suppression of the image in the divergent eye, by causing the patient to wear a colored glass—red or blue—before one or other eye. The effect of the glass over one eye during binocular vision is to faintly tinge the images of objects with that color. Should one eye diverge and its image be suppressed, then the remaining image will be white or deeply colored according as there is or is not a colored glass before the eye that continues to fix. He instructs the patients to recall their wandering eye to its duty when such a change in the color of the images takes place.

Bishop Harman has tried the recommendation on patients with this tendency to divergent squint on fatigue, and made some other experiments. He finds that a colored glass over one eye so reduces the illumination admitted into that eye as to disturb vision and increase the tendency to squint.

To avoid this he tried placing a colored glass before each eye, one eye red, the other blue; the tints were light, and equal in the amount of illumination cut off by the color. If the color tints were well balanced and there was binocular vision then little if any disturbance of the color vision occurred; but if a natural or artificially induced squint took place, then there was an instant alteration of the appearance of things: either there was vision of two sets of objects, one blue the other red; or else, with the suppression of the images of the squinting eye, the images seen were red or blue as according to the color before the fixing eye.

Harman believes Poullain's idea to be very good, and with the modification suggested worth trying in serious cases. On the other hand, experience goes to show that these intermittent divergent squints do not tend to get worse or to become permanent.

Krusius (*Oph. Year-Book*, p. 102, 1909) reports two cases of *divergent strabismus in hyperopes,* which vanished upon atropinization of the fixing eye. He thinks that the excessive nerve impulse directed to the paretic ciliary muscle was accompanied by a concomitant impulse to the internus of the diverging eye, giving rise to parallelism of the two.

For the purpose of occluding the fixing eye of squinters, Dreisch describes a form of *occluding spectacles.* A half glass receives a covering of some soft material, which covers the eye at its orbital border without pressure. The apparatus is fastened around the head by tapes attached to the frame by hooks. The same apparatus can be used when a bandage for one eye is required. Krusius advises correction of the amblyopic eye, and making the other eye ametropic, by lenses to the same degree as the squinting eye exhibits without correction.

Holzer's modification of the Priestley Smith tape measurement of esotropia. Wm. F. Holzer (*Am. Journ. Ophthalm.*, p. 520, July, 1919) believes that the tape measurement of squint (see p. 8105, Vol. XI of this *Encyclopedia*) does not commend itself as highly as it should, if one may judge from the descriptions usually given in our text books. In most books the tape method is briefly dismissed, oft times with a foot note, or goes unmentioned. Some of the descriptions present a vagueness in the method of its application, neglect to name length of tape or define gradations; and some present contradictions as to position of corneal images.

A very important and yet often neglected step in the estimation of a squint is a regard for the angle gamma, or angle kappa of Landolt. The Priestley Smith tape method as described by Worth accounts for the angle, without the necessary separate determination, and addition if positive to convergent and deduction from divergent squints; and vice versa if negative. Worth says, in part: "The patient is first told to fix the mirror, while the light of a lamp is reflected into the fixing eye. The position of the image of the mirror, on the cornea of the fixing eye, is noted. The light from the mirror is now thrown on to the deviating eye, and the patient is directed to look at the surgeon's tape hand. This is moved horizontally, till the position of the image of the mirror on the cornea of the squinting eye, is similar to that which it formerly occupied on the cornea of the fixing eye." (Corresponding to the visual axis of the eye.) Practically every other description of the method of application directs the image of the mirror to be placed in the centre of the cornea, which corresponds to the optic axis of the eye; thereby disregarding the angle gamma.

Two criticisms are apt to arise; first the deviation when fixing at six metres compared with fixing at one metre or at sixty centimetres (length of the later tape); and, second, the error due to measurement on the chord of the arc as compared with measurement on the arc. Maxwell demonstrated that the angle measured at twenty-five centimetres (less than the length of the tape) averaged 2.1 degrees greater than at six metres. The "mathematical error" (the difference between an angle measured on the arc of a circle and the chord of the arc) is so small as to be practically negligible. On the other hand the "observation error" (the inability of the observer to place exactly in a corresponding situation on the deviating eye the position, centric or eccentric of the corneal image in the fixing eye) is common to most methods of measuring deviations, the degree of accuracy depending upon the skill of the individual observer.

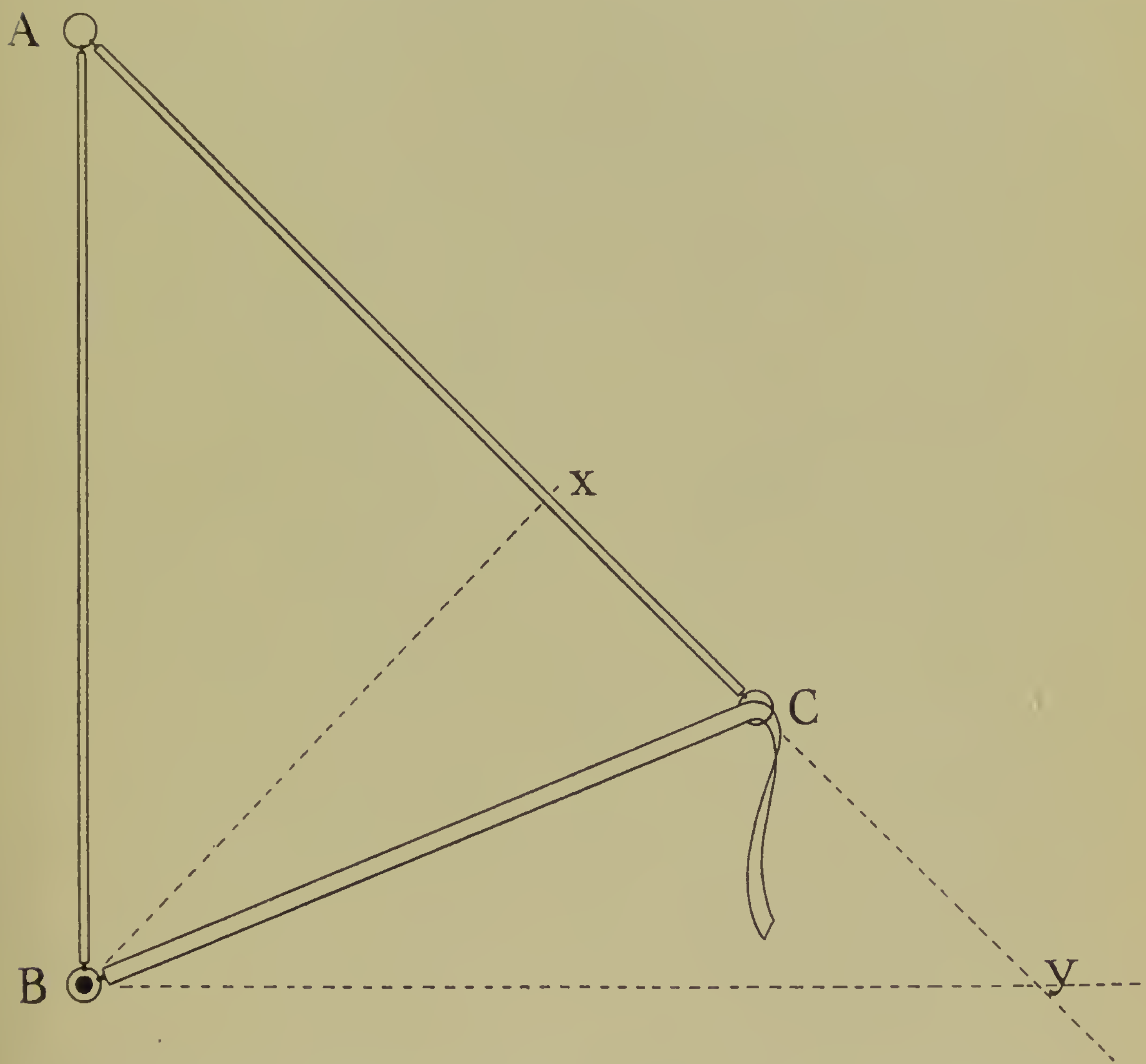
The writer has made a slight addition to the Priestley Smith tape, very simple but which he deems quite important; never having seen it noted. It is the addition of a "constant radius," by means of a tape from the ring, held by the patient against the cheek, to the hand of the observer which slides along the graduated tape, maintaining a constant radius.

A cloth or steel tape graduated in centimetres, two pieces of half-inch cloth tape, measuring with rings attached sixty centimetres, and three one-inch steel or nickel rings, one to three sixteenths of an inch thick, constitute the necessary materials for the tape.

The accompanying diagram illustrates the position of the tape in the measurement of a concomitant squint of 45 degrees. To A (ring held by patient against cheek) is attached tape A B and ring B (through which the ophthalmoscope handle is placed). B C represents the tape graduated in centimetres (1 cm. = 1 degree) attached to ring B and passed through ring C. The tape A C is the writer's addition. Being the same length as A B it maintains a constant radius as the hand slides along the graduated tape passing through ring C. B C represents the chord of an arc of a circle whose radii are A B and A C.

The determination of deviation is made by the Priestley Smith method. Holzer says, let us take for example a convergent squint of the left eye. Measurements should be made in a dark-room with a lamp situated behind the patient. The ring A is held against the right cheek below the fixing eye by the patient. An ophthalmoscope or retinoscope handle is passed through ring B and held in the observer's left hand. The image of the light behind the patient is now reflected from the mirror of the ophthalmoscope or retinoscope

into the fixing eye, and the patient is directed to fix the mirror. Through the sight-hole in the mirror the observer notes the exact position of the corneal image. He now turns the mirror to the left eye, the patient still fixing the mirror with the right eye, and notes that the image on the left cornea is situated eccentrically outwards,



Position of tapes in Determining Squint of 45 Degrees, Showing Advantage of Additional Tape AC. (Holzer.) This prevents errors from holding tape BC too near patient (X) or too far away (Y).

showing that this eye deviates inwards. He now directs the patient to follow, with his fixing eye, a finger of the observer's right hand over which ring C has been placed. The right hand is gradually moved horizontally outwards along the tape B C while the observer notes the changing position of the corneal image through the sight-hole of the mirror, until the left eye has rotated outwards enough to bring

the image to the *corresponding situation* occupied in the fellow eye (right) when that eye was fixing the mirror. When this point is reached he pinches the tape and reads off the degree of deviation; one centimeter on the tape equalling one degree of deviation.

The same position of the hands and tape can be employed in measuring a divergent squint of the right eye, with the left eye fixing. To measure a convergent squint of the right eye or a divergent squint of the left eye the principle is the same but the hands and tape are reversed. The tape can be held taut between the ring and the finger, obviating the necessity of the weight usually mentioned.

The diagram illustrates at a glance the "constant radius" maintained by the writer's additional tape A C. It presents graphically the advantage of the tape in avoiding errors by faulty position of the distal end (C) of the graduated tape B C. A reading made with the tape in the Bx position would be less than that made at B C, because the distance between the patient and the end of the tape at x is less than 60 cm. With the tape occupying the position By, the reading will be greater than that made at B C, since the distance from the patient and the distal end of the tape at y is greater than 60 cm.

This method is applicable to almost every case. Parsons says: "This test is by far the best for small children of any yet devised." It is almost a purely objective test, accurate, rapid and simple. The tape is compact, portable and inexpensive.

FUSION TRAINING.

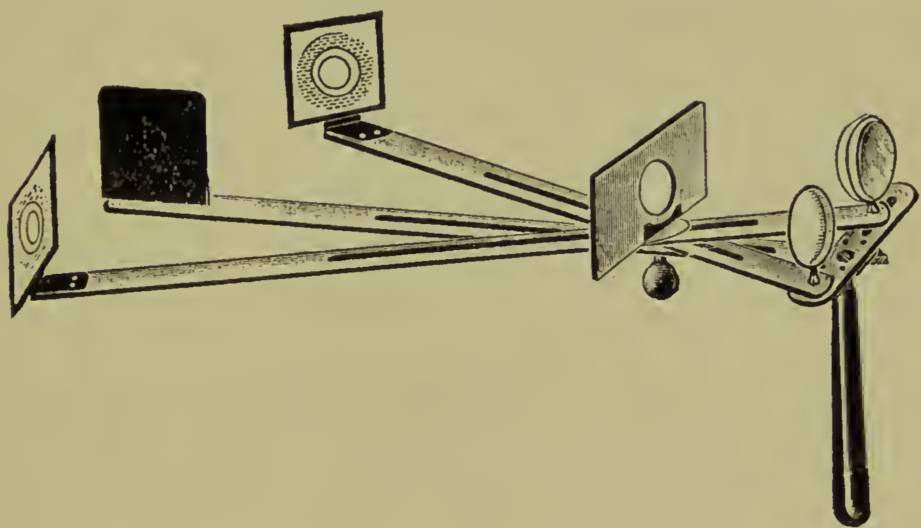
Krusius has modified the well known Worth amblyoscope (q. v.) so that the object for each eye may be alternately illuminated rapidly or slowly, as may be desired. He has also so contrived the joint of the two parts of which the instrument consists, that the same can be employed in every variety and degree of squint, with the eyes in any position, adapting it especially for such patients in whom simultaneous vision with the two eyes is impossible, but in whom alternate presentation of one object to each eye is necessary to commence the education of the fusion sense.

Experiences with Remy's diploscope. See p. 4011, Vol. VI of this *Encyclopedia*.

In Polack's case (*Oph. Year-Book*, p. 103, 1909) 15° of convergent strabismus persisted after correction of the hyperopia, atropinization, prism exercises and colored glass, but yielded finally to Remy's diploscope. Bourdeaux has adapted Remy's diploscope for variable distances. He claims that by beginning with the intersecting point of convergence, binocular vision is secured in a surprisingly short time.

Drouin reports a case of a woman, aged 32, affected with congenital amplyopia and divergent strabismus, in whom perfect binocular vision was restored in two months by the use of Remy's device and correction of the ametropia. Interest in this case attaches to the exceptional age of the patient.

A. C. Hudson (*Ophthalm. Review,* Dec., 1911) has devised a *simplified form of the amblyoscope* (q. v.) which consists of two wooden bars crossing one another diagonally, each of which is 33 cm. in length, and is provided at its distal end with an upright picture carrier, and at its proximal extremity with a lens of a strength of + 3 D combined with a prism base inwards. Each bar is perforated by a central longitudinal slot, and through both slots passes a stout upright pin carrying a screen with a small central diaphragm, which is thus capable of a



Hudson's Simplified Form of Amblyoscope.

considerable antero-posterior excursion. The distance between the lenses can be varied to correspond with the interpupillary distance of the patient by means of a simple screw and slot arrangement, while that between the pictures varies with the position of the diaphragm screen. The strength of the prisms is such that when the two picture carriers are in apposition one to another an orthophoric individual will obtain accurate fusion of the images of the pictures. Approximation of the diaphragm screen to the proximal end of the instrument leads to an increasing separation of the pictures, the angle between the visual axes of the observer necessary for the maintenance of fusion of the images in any given position of the screen being indicated by a semi-circular scale attached to the screen; in this manner the two pictures may be so placed as to lie in the visual axes of the two eyes in any case of convergent squint. The central bar gives increased

steadiness to the crossed bars, and also serves to carry a screen by means of which a variation in the relative illumination of the two pictures may be obtained. See the figure.

In the investigation and treatment of a case of convergent squint the crossed bars are at first set at an angle corresponding with that of the squint, and the presence or absence of binocular vision and of the stereoscopic sense is ascertained; the examination being aided when necessary by a relative variation in the illumination of the two pictures. Binocular vision having thus been elicited the diaphragm screen is moved slowly forwards, the movement being accompanied by an approximation of the pictures, and consequently, as long as fusion is maintained, by an approach towards parallelism of the visual axes. This movement is continued until binocular vision can no longer be maintained, as shown by the patient's statement that he sees only half of the diagram, and by a sudden movement inwards of one eye. A reversion is then made to the original position of the diaphragm screen, and the process is repeated. The diagrams devised by Worth are admirably suited for these exercises.

The instrument has the advantage of simplicity, both in principle and construction, so that its application can be satisfactorily explained to the parent of the patient, a fact which, combined with its inexpensive character, renders it suitable for home use.

Retinal control after squint operation.—Ohm finds that no two cases behave exactly alike. Three stages can be distinguished, but they are not always distinctly marked. Anomalous localization persists immediately following operation, in spite of the changed positions of the eyes. This change does not, as a rule, occasion double images, as occurs in normal vision. An "interior inhibition," as Tschermak termed it, comes into play, but the paradoxic double images can be brought out, though at times with difficulty, by suitable methods. Abnormal localization usually follows a prolonged struggle between abnormal and normal localization. This struggle may, however, begin immediately after operation. The retina develops double references, and hence arise monocular diplopia and binocular triplopia, the latter being more frequently observed than the former.

Normal localization follows the period of struggle, or else immediately follows the abnormal. But normal binocular vision with proper perception of depth does not occur at once, even when localization has become normal and the eyes are in a satisfactory position. This has to be painfully acquired. The fusion impulse is absent, and the union of the two images in one does not take place. Indifference to fusion, even if there be no opposition, here plays a rôle. True per-

ception of depth was absent even where fusion of stereoscopic images occurred after prolonged exercises. The author was unable to determine the existence of perfect binocular vision in any case. The period after operation when the tests were made was comparatively early, but the progress made in a short time seems to justify the hope that more prolonged training by exercises will lead to a perfect result.

Squint and its treatment under control of the stereoscope. That in the vast majority of cases there is required for the production of squint a special innervation which is absolutely independent of the refraction of the eye is a conviction of Bjerke (*Prac. Med. Series;* Eye, p. 145, 1910). This theory explains why either inward or outward squint may occur with any form of refraction, and why not all hyperopes squint inwards, and all myopes outwards. The refraction has only a favoring influence upon strabismus—this is the only truth in Donders' theory.

In operating the writer proceeds as follows: Under cocain anesthesia the tendons of both internus and externus are laid bare; a suture is then passed through the tendon of each muscle and fastened at the sclerocorneal margin. The tendons are then severed and the eyes brought apparently parallel and one knot tied in the suture. The patient then looks into a stereoscope and sees if the two half pictures are together. If not, while the patient still looks into the instrument, the knot is tightened with a pair of pincers until the double pictures fall together. The result is controlled by means of the Maddox rod, and if not perfect the knot is unfastened and the direction of the eye modified until the line cuts the light.

More recently Walker (see *Oph. Year-Book,* p. 69, 1916) believes with Worth that *faulty development of the fusion faculty* is the chief cause of squint. His non-operative treatment is divided into four parts. 1. Correcting of error of refraction. 2. Occlusion pad. 3. Atropin in the fixing eye. 4. Stereoscopic treatment with Worth's amblyoscope. Considerable space is given to instructions for using the amblyoscope. Sellers prefers to wait until the age of twelve to fifteen before operating and then does advancement of the weak muscle and tenotomy of the strong. He uses the Reese operation which he describes in detail.

Reber says that *treatment of strabismus in the early stages,* whether convergent, divergent or vertical, is non-operative. He gives two factors for its predisposition, first, an essential defect; second, a peripheral defect. In its treatment the two prime essentials are the correction of these two defects. The four conditions to be considered in handling these cases are the visual acuity, the degree of deviation, the refractive status and the status of the fusion faculty. He is in favor

of bandaging the good eye, atropinization and invisible bifocals to prevent the use of accommodation, decreasing the amount in the segment each year for three years. The treatment when successful is far superior to the operative, and even when unsuccessful makes ideal preparation for operative work later.

Mendoza describes a method to *stimulate binocular vision.* It consists of a card 30 centimeters wide which is held in front of the eyes and almost in contact with the nose, while a picture or a page of reading matter is placed at 1 centimeter from the farthest side of the card. An effort is then made by the patient to see the picture or reading matter as a whole. By moving the edge of the card away from the patient the amount of the picture seen by either eye is increased or diminished. Suker offers a new card for use in the ordinary stereoscope consisting of a plain card ruled with lines numbered vertically and horizontally from a center point. Pictures may be cut from periodicals and pasted on this card thus keeping up the interest of children in the use of the stereoscope. They are pasted according to the insufficiency being treated.

C. Sauvineau (*Bull. Acad. de Méd.*, June 10, 1919: abst. *Journ. Am. Med. Assocn.*, p. 369, Aug. 2, 1919) believes that the *deviation of one or both of the eyes is only a secondary symptom of strabismus.* The essential disturbance with strabismus is inability to focus the lines of vision on the object, and this, he insists, is the result of an anomaly in the perceiving centers in the brain. Only the visual image from one eye alone is perceived. The cross-eyed are cerebrally blind of one eye. Both eyes may be visually perfect but the brain perception is monolateral; the brain neutralizes or drops out the image furnished by the deviated eye. Treatment should consist in training the brain centers to bilateral vision; the deviation of the eyeball will then usually correct itself spontaneously. He accomplishes this with glasses of complementary colors, green for one eye and red for the deviated eye, through which the subject looks at the flame of a candle through a hole in a screen. At first he sees only the green flame, but by shutting off the eyes alternately he sooner or later finds that he can see a red flame along with the green. This diplopia is converted into normal vision of one flame (theoretically white from the fusion of the two complementary colors), by having the subject relax or contract his convergence, guided by the red and green luminous points. If the strabismus is mild, he soon succeeds in this fusion of the two luminous points into one. Sauvineau has thus conquered strabismus of 30 and 40 degrees in less than three months. With these pronounced cases, he says, it is better to graduate the efforts by the aid

of prism glasses. With a prism glass properly placed, the green and red images are brought closer together till they are only a few centimeters apart and the subject easily fuses them. Then weaker prisms are used until binocular vision is reestablished. He declares that a cure can be realized in every case by this simple means (amblyopia is not an obstacle), which can be applied by any practitioner. Of course the procedure succeeds only with true strabismus, not with insufficient convergence from latent diplopia. The tendency to true strabismus seems to be inherited, and the slightest obstacle to binocular vision is enough to bring it on.

Writing on the *status of strabismus to date* Herbert W. Wootton (*N. Y. State Journ. of Med.*, Feb., 1915; review in *Ophthalmoscope,* Aug., 1915) regards the amblyopia from disuse theory as so far unproven, but he does think it a primary factor in the etiology of most cases of strabismus. His own experience of exercises with Worth's amblyoscope have not yet convinced him of their extreme utility. He does not deny that a squint progressing towards cure by means of glasses may possibly be assisted by stereoscopic exercises, but he has yet to be convinced that in such cases a cure would not have resulted from glasses alone. When he has failed to restore binocular vision by glasses or operation, he has never succeeded in securing it by means of the stereoscope.

Were it not for other factors, the advancement of both externi would seem to solve the problem of the operative treatment of convergent strabismus. But the relative degree of amblyopia and the esthetic effect likely to follow operation must not be left out of count. A double advancement depends for its success upon faultless technique, and naturally this cannot always be guaranteed. There are other drawbacks to advancement of the externi, such as the prolonged after-treatment, the occasional excessive reaction, and the more or less permanent "yellow blotch" left at the site of operation. Wootton, therefore, believes that the operation should be employed in those cases only in which the sight of the squinting eye is good enough to render it probable that a serviceable degree of binocular vision will result. For example, should the squinting eye possess vision of only 20/200 as opposed to 20/20 in the "fixing" eye, it would be useless to expose the patient to the pain, inconvenience, and possible danger of a double advancement. Under such conditions, a single or double tenotomy would seem to be the proper procedure. With deeply-set eyes, advancement is exceedingly difficult, and the result is not good. The importance of binocular single vision in the ordinary affairs of life has been somewhat exaggerated. Even when no great degree of amblyopia is present in the squinting eye, it appears to Wootton that a single

or double tenotomy is, all things considered, the best procedure. Advancement of both externi, as advocated by Landolt, is recommended when the squinting eye has sight of at least 20/70, when the globes are tolerably prominent, when the technique is perfect, and when the operation leaves no noticeable disfigurement.

The same writer (*Ophthalmoscope*, 1916; review, *Annals of Ophthalm.*, p. 575, July, 1916) discusses *divergent concomitant strabismus and its treatment.* The difficulties attending its rectification by surgical procedures are, the writer points out, generally held to be greater than those connected with the correction of convergent strabismus. Amblyopia of the squinting eye defying improvement by correction of the refractive error is by no means common, and, if we believe that the irremediable amblyopia of strabismus is for the most part congenital and not acquired, it does not seem to present itself as an etiologic factor as frequently as in the convergent variety.

On the basis of the predominating muscular error, the writer classifies divergent strabismus as follows: 1. Divergence excess; hypermetropia frequent; myopia rare. 2. Convergence insufficiency; myopia frequent; hypermetropia rare. 3. Divergence excess (marked) and convergence insufficiency; anisometropia frequent; bilateral myopia and bilateral hypermetropia less frequent.

The order given is in the order of frequency in Wootton's experience.

The determination of the muscular anomaly or anomalies existing in any case of divergent strabismus is exceedingly simple. In uncomplicated cases of divergence excess the deviation exists only when the patient gazes at distant objects; or, if it be present, although to a less degree, for near points, the power of convergence can be shown to be practically unimpaired by insisting that the patient shall attempt fixation of some test object, such as the point of a lead pencil gradually brought nearer to him in the middle line. In typical cases, which are very frequent, he will maintain bilateral fixation until a point within three or four inches of the root of his nose is reached. Obviously, when this is the case, convergence insufficiency cannot be present. In uncomplicated convergence insufficiency the squint will be more marked for near than for distant objects, one eye diverging more and more as the pencil approaches the face. When both divergence excess and convergence insufficiency are present, the deviation will be marked during both distant and near vision, and the power of convergence will either be entirely absent or will manifest only to a slight degree. In all pure cases of divergence excess the extent of the external rotation of each eye will be found to be markedly increased, and not infrequently to comprise an arc of seventy degrees.

In the *treatment of divergent strabismus* it is generally held that our first endeavor should be to correct the refractive error, and that, after such correction, a cure may result without resort to operative measures. A cure may thus be obtained, but only in those cases in which myopia fairly equal in degree is present in both eyes, and in which convergence insufficiency is the sole, or greatly predominating, muscular anomaly. Correction of the refraction produces no effect when the deviation is due to a divergence excess. It follows, then, that most cases of divergent strabismus necessitate operative measures for their cure, and the results are, generally speaking, exceedingly satisfactory and frequently perfect, if we are guided in our choice of operation by the muscular anomaly present. The most frequent cases are those of bilateral hypermetropia associated with divergence excess, and in these the proper procedure consists of a free tenotomy of both externi, repeated, if necessary; and this is no less true when, as is rarely the case, the divergence excess is accompanied by bilateral myopia. In the hypermetropic cases, even if a fairly well marked convergence insufficiency coexists, the tenotomies should constitute the primary measure, and should be persisted in until the deviation is corrected for distant vision.

Cases of myopia associated with convergence insufficiency, in which the deviation persists after full correction of the refractive error, require the advancement of one, or more generally of both, interni; and in no circumstances should tenotomy of the externi be performed in pure cases of this type. When both divergence excess and convergence insufficiency in marked degree are associated, the predominating muscular error, which, except in cases of bilateral myopia, is usually the divergence excess, should be first attacked by means of free tenotomies of the externi.

Treatment of cases of strabismus in children with definite dissociation of the eyes. Bishop Harman (*Oph. Year-Book,* p. 72, 1916) found this condition in 2 per cent. of the cases examined and in girls about twice as frequently as in boys. In the Belgrade Children's Hospital out of 1,400 examined 199 were squinters—191 convergent and 8 divergent; fixed in 166, alternating in 16 of 182 uncomplicated cases. He thinks squint a reversion, a return to monocular vision which is normal in lower vertebrates. The evolution into binocular vision is traced. It is the brain which controls binocular vision, through the fusion faculty and through stereoscopic vision, which is the outcome of the variation in angle of view. The faculty is not developed before the third or fourth year and is unstable, the control being affected by irritants such as pin pricks, worms and attacks of indiges-

tion. As to heredity, it is not the squint, but the causes which are transmitted.

Harman divides treatment into three stages: First, balancing the visual acuity; second, awakening the fusion faculty; third, operation. The first includes complete cycloplegia and careful refraction, with correction to be worn no matter how early in life, the carrying frames being occasionally tied on for young children. The second, training, is by covering the better eye several hours each day—or by atropin in the better eye. Stereoscopic training by the method of Darwin (first published in 1778) and by the more modern methods are also employed. The influence of any such practice is in proportion to its continuity, but it prepares the way for surgical measures.

Operation is put under four considerations. 1. The rationale of the procedure. 2. The most favorable time. 3. The best technic. 4. The prospects of success. As to rationale, operation on the case may be thought of as to the cosmetic or as to the binocular value. Conditions are favorable for operation even if the vision is reduced to 33 per cent., and the earlier it is done the better. If the child goes to nine or ten years of age with no improvement, operation may be done for cosmetic effects. In alternating types there is no value from training and operation may be done early.

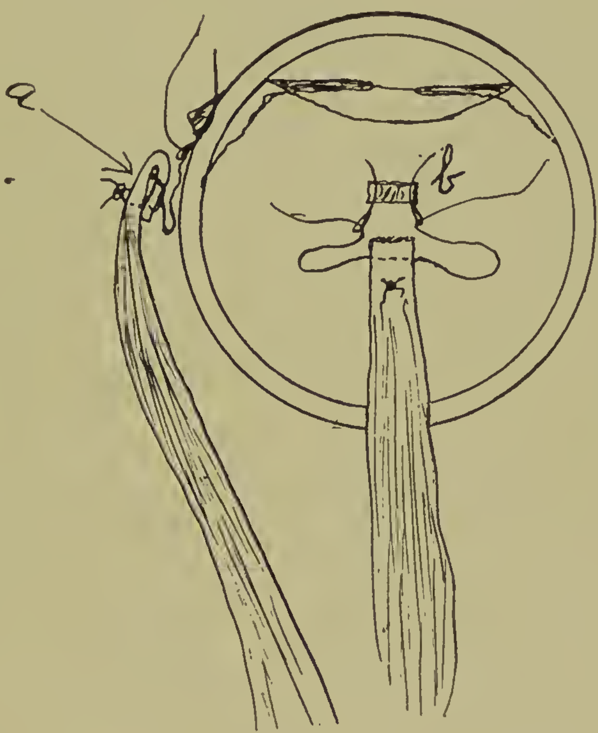
Harman summarizes the first one hundred cases of operation as follows:

Males 43; females 57; 48 were 10 years of age or under; 39 were 10 to 20 years; 12 were 20 to 30 years; 1 over 30; 93 were for convergent (57 fixed and 36 alternating); 6 divergent; 1 vertical; 81 cases had correction at first operation; 19 cases showed partial correction.

Results—

Binocular vision restored in (the small number being due to lateness of operation)	4	
Cosmetic correction complete in	36	
Cosmetic correction error less than 3°	22	
Cosmetic correction error above 3°	23	
Successful		85
Uncorrected 6-10°	9	
Uncorrected 10-20°	4	
Overcorrected	1	
Diseased	1	
Unsuccessful		15
		100

The operation of choice was his advancement, done by reefing over rasped hooks. For cases up to 15° the simple reefing is done, each millimeter of reefing correcting 2 to 2½ degrees. In high degrees 8 to 12 millimeter reefs were made, and sewed to the globe by sutures into the limbus. Both procedures are helped by the jigsaw operation (Todd). "One-half jigsaw" is done for the vertical lengthening. Local anesthesia is employed. The post-operative treatment is merely covering of the eye, the cover and stitches being removed on the eighth day. Use of the eyes for near seeing is interdicted for a month in children.



(*a*) Loop made by Tendon and Suture. (*b*) Advancement Suture passing through Tendon Loop and Needles in Stump of Tendon. (Huizinga.)

J. G. Huizinga (*Am. Journ. of Ophthalm.*, p. 605, Aug., 1919) thus describes his new *method of suturing the muscle in advancement operations*: The tendon of the muscle which it is desired to advance is cut at right angles as close to its insertion into the eyeball as possible. The muscle is grasped with any advancement forceps, to prevent it from slipping back and to assist in drawing it forward, etc. The end of the severed tendon is folded back upon itself *beneath* the muscle and held in position by passing a suture through the tendon and muscle, thus forming the end into a loop. A double-needled-thread is passed through this loop. These needles and thread are then passed through the stump of the tendon, still inserted into the

eyeball, and partly through the sclera in the usual way. The tying of this last suture and the advancing of the muscle is accomplished as in other operations and they are left in place for the usual length of time. See the figure.

Huizinga claims for this operation that the sutures cannot pull out or cut their way through the muscle; and if they are properly placed and tied to the stump and sclera, the result obtained will be perfect.

Oculomuscular defects produced by operations for strabismus and heterophoria. An important essay on this subject is published by Frank C. Todd in the *Journ. Am. Med. Assocn.*, p. 264, July 22, 1916. He remarks that cases of strabismus produced by operations intended to correct strabismus or heterophoria are not uncommon. Perhaps it would be better to call such conditions deformities. In these cases, one or more operations may have been performed to relieve the condition. These *post-operative anomalies* may be classified under four heads: 1. Cases in which operations have failed fully to correct the strabismus, that is, wherein the strabismus remains, is undercorrected, or is increased. 2. Cases in which an overcorrection has occurred and strabismus of the opposite kind, though in the same plane, exists. 3. Cases in which strabismus in a different plane has resulted, usually combined with one of the failures classified above. 4. Cases of exophthalmos or enophthalmos.

In general, it may be said that few failures would result if all cases were thoroughly studied and the indications for operations more carefully considered.

When a post-operative squint presents itself the following questions arise: 1. Should any operation be performed? 2. At what age should operation in the case under consideration be undertaken? 3. What muscle or muscles should be operated on? 4. What method of operation should be practised? 5. What treatment should be given subsequent to operation?

Class 1: Incomplete results may be caused by insufficient tenotomy. While it is never best to sever a tendon completely, it is necessary to cut all of the tendon fibers in one place or another in order to secure any relaxation, and if any fibers remain, failure to secure the desired effect will exist. In the operation of limited tenotomy in which the tendon fibers have been cut in one place or another and relaxation does not occur, it is due to the fact that there are some uncut fibers on one or both sides, and these should be engaged in the hook and severed.

A tenotomy may be insufficient and an advancement operation may be required in addition.

Cicatricial contraction following tenotomy of any kind may result

in a reduction of the effect at first produced by the tenotomy. This may be prevented or minimized by making the conjunctival incision parallel to and at one edge of the tendon so that the cut edges of the conjunctiva may not come in contact with the cut tendon.

Another very frequent cause of failure to secure the desired effect is through the performance of an improper advancement operation. It sometimes happens that sutures in an advancement operation may cut through the tendon of the muscle. It is very easy for this to occur if the sutures are merely inserted into the tendon, as they naturally pull in the direction of the fibers and cut through. In order to prevent this catastrophe, it is necessary to ligate the tendon in one manner or another. And again, the suture may cut through the sclerotic coat. This may be obviated if the suture is placed near the margin of the cornea and is well engaged in the sclerotic coat at right angles to the line of traction that it exerts. The force is thereby divided. Strong silk thread should be used. In case the suture cuts through the tendon or the sclerotic coat and the tendon has been severed, it may become completely lost, so that the effect of a tenotomy is produced, thereby increasing the degree of the strabismus already existing. Most forms of advancement operations do not permit of regulation, and the operator makes a guess as to the amount of effect that he will secure from his advancement operation. In other words, the results are governed by fate. There are now several operations which may be performed which will enable the operator to regulate the effect to some degree, and one of these methods should be selected.

Herein lies the advantages of a tucking operation. If the sutures slip or cut through, the tendon is not lost; but if properly inserted, they will not cut through or slip. The operation of tucking, Todd claims, not only holds the tendon firmly, but also permits of great advancement and of careful adjustment, and for these reasons seems to have as distinct advantages as any other advancement operation in squint. See p. 8229, Vol. XI of this *Encyclopedia*.

Class 2: These cases are also not uncommon. They occur very often as a consequence of the performance of complete tenotomy on one or both external recti for convergent strabismus, bringing on a subsequent divergent strabismus. Most of these patients have been operated on early in life, and are cases in which no operation should have been performed. Sometimes they are cases in which the wearing of glasses would have resulted in an eventual cure or in which the strabismus might have corrected itself at a later age. Some of them, however, are produced by operations in later life.

In these cases complete tenotomy has been performed on one or both

muscles. Rarely an advancement operation has been done in addition to the tenotomy, but this is not commonly the case because the advancement operation seems to be avoided because of its greater difficulties.

The prevention of deformities of this class is thus apparent.

If an operator finds a greater effect than he desires to produce after tenotomy, either at the time of operation or a few days later, he should endeavor to recover the tendon and stitch it forward on the globe. If his advancement operation is too great, then he should be able to relax the tension, and if adhesions have already formed, the tendon should be hooked up and the eye forced toward the opposite side, thereby stretching or breaking the adhesions sufficient to secure the desired effect.

Rarely should a tenotomy be performed on young children; never until all other measures have failed after a long period of effort; never when any improvement is occurring as a consequence of wearing glasses, however slow the improvement, and never unless the case has been carefully studied and the proper operative procedure selected. It is impossible to tell what the conditions are going to be at a later period of life, and the chances of producing an ultimate greater and far more severe deformity (one which is still more difficult to correct) are more than even. It seems to be agreed that single binocular vision cannot be brought about after an early age. Tests and practice with the amblyoscope may enable us to determine whether or not such a prospect exists, and it may be wise in some cases to operate early if we feel that such operation may facilitate the production of fusion. It is sometimes possible to produce fusion and even stereoscopic vision in later life.

If we are simply to secure a cosmetic result, there is no reason why the operation should be performed until the patient has reached an age when local anesthesia may be used. In any event, if a tenotomy is to be performed, it should not be free and complete because the tendon may not become reattached to the sclerotic coat. The sclerotic coat is shiny and smooth, and unless denuded by trauma or in some other manner, the tendon will not reattach itself to the globe. A complete and free tenotomy is never necessary, for by cutting the tendon on either side in three places, it is possible to produce just as much effect as may be produced by complete tenotomy.

Class 3: If a complete and free tenotomy is performed, the tendon may fall back and reattach itself farther up or down than was formerly the case, thus producing a complex strabismus involving a different plane. Advancement operations involving the severing of the tendon, which is then sutured to the globe, may alter the plane of action.

Herein again, thinks the writer, lies the advantage of the tucking operation.

Class 4: This class does not need much consideration. Exophthalmos may be produced by performing a tenotomy on two opposite muscles. This sometimes occurs when an operator seeks to correct an overcorrected strabismus which has been produced by a tenotomy. Exophthalmos thus produced by too extensive tenotomy may be improved by advancing the tenotomized muscles. Similarly enophthalmos might possibly be produced by too extensive advancement not accompanied by tenotomy.

The correction of deformities. It is impossible to lay down any specific rules as to the correction of deformities produced by operations intended to cure strabismus, for, like plastic operations, each one is, to a certain extent, a law unto itself.

As a general rule, it is better to work on the muscle which has become wrongly attached, as when an internal rectus has been tenotomized, giving rise to a divergent strabismus, an effort should be made to find the internal rectus tendon and bring it farther forward on the globe. In this instance the tendon tucker will be found of great service, as it is difficult otherwise to secure sufficient hold on the tendon. With the instrument, the tendon may be forcibly brought forward and reattached. It may be necessary in order to relax the tension to do a limited tenotomy on the opposite muscle. It sometimes happens that the tenotomized muscle cannot be found, for it has not become reattached to the sclerotic coat. It is reasonable to believe that such a muscle has still some power, for the tendon is engaged in the capsule of Tenon and is prevented from slipping way back into the orbit by the check ligaments, and this opinion is confirmed by the results Todd has had in advancing a mass of capsule. In those cases there has been secured sufficient power of rotation in the direction of the advancement to lead to the belief that the lost muscle had again become active.

Following is Todd's method of performing a *capsular advancement* where the tendon of the muscle cannot be found after it has been tenotomized: An incision is made about a quarter of an inch from the margin of the cornea concentric with the margin. It having been found that the tendon is not attached to the globe, the mass of capsule is engaged in a pair of broad fixation forceps, this mass being grasped well back and from the scleral surface of the capsule. The mass of capsule thus engaged is now twisted once around to give it body. It is now engaged with two sutures applied from within out, which are inserted deeply into the tissues. Each of the sutures is now inserted into the episcleral tissues near the margin of the cornea at right angles

to the tendon. The under surface of the capsule that is to come in contact with the eyeball is slightly scarified, and the sutures tied. The effect is regulated by the distance backward that the sutures are engaged in the capsule and by the tenseness of the knot.

In case a deviation has been produced in a different plane, it will be found that the muscle which has been tenotomized has become reattached farther up or down on the globe, giving rise to a deviation in the opposite direction from the place the tendon is attached; and it will be necessary to sever that portion of the attachment which is misplaced. The tendon then should be tucked and the portion that is folded reattached in the correct location on the globe, care being taken in the tying of the sutures so to regulate the effect as to correct the strabismus in the various planes. Here, too, it may be necessary to obtain a relaxation of the opposite muscle by the performance of a limited tenotomy. For the various operative procedures in strabismus see p. 8153 *et seq.*, Vol. XI of this *Encyclopedia*.

Strabismus, Absolute. That which occurs at all distances for the fixation-point.

Strabismus, Alternating. The form in which the deviation affects now one eye and then the other. It is generally a form of comitant squint. See **Muscles, Ocular.**

Strabismus, Angle of. Angle of squint. See **Angle of deviation,** p. 474, Vol. I of this *Encyclopedia*. See, also, the figure on the ne. following page.

Strabismus, Apparent. Owing to the size of the angle *alpha* (see p. 470, Vol. I of this *Encyclopedia*) we not uncommonly see an apparent excess convergence of the eyes in myopes and divergent squint in hypermetropes. Donders (*Accommodation and Refraction of the Eye*, p. 248) fully discusses this matter. The same condition was described by Johannes Müller (*Zur vergl. Phys. des Gesichtssin.*, p. 230, 1826 . under the name *Strabismus incongruus*.

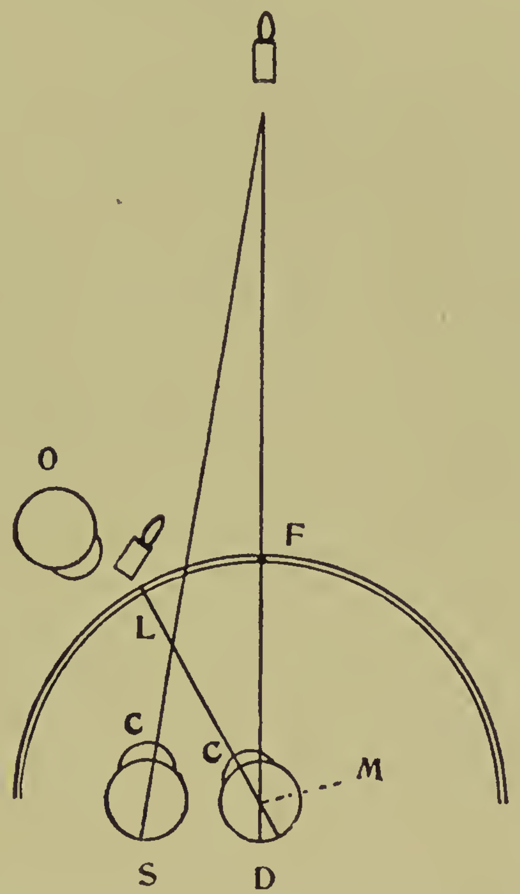
Strabismus, Braid's. The turning of the eyes simultaneously upward and inward; a means sometimes adopted of inducing the hypnotic state.

Strabismus, Concomitant. Concomitant squint. Comitant squint. In any variety of comitant or concomitant squint—as the adjectives imply—the non-fixing eye generally follows or accompanies all the movements or excursions of the fellow organ. In other forms of deviation—paralytic squint, for example—there is a limitation of these excursions, so that the deflected eye does not necessarily accompany the ocular movements of the other eye. See p. 8095, Vol. XI of this *Encyclopedia*.

Strabismus comitans. See **Strabismus concomitant.**

Strabismus, Convergent. See **Esotropia,** p. 4523, Vol. VI of this *Encyclopedia.*

Strabismus deorsumvergens. DEORSUMIVERGENT SQUINT. Downward squint, in which the visual axis of the squinting eye passes lower than the fixation-point of the other eye. See **Muscles, Ocular.**



Measurement of the Angle of Squint. (Ball.)
D, Squinting eye. S, Fixing eye. O, Observer's eye. L-M-F, Angle of squint. C, C, Centre of corneas.

Strabismus, Divergent. See pp. 4051 and 4052, Vol. VI of this *Encyclopedia.*

Strabismus, Dynamic. The tendency to strabismus due to insufficiency of the ocular muscles, but which may be overcome by the effort of binocular vision; *heterophoria.* See p. 5910, Vol. VIII of this *Encyclopedia.*

Strabismus hook. These numerous devices are pictured and described under various headings, but especially on p. 5999, Vol. VIII of this *Encyclopedia.*

Strabismus, Incongruus. See **Strabismus, Apparent.**

Strabismus knife. Knives have rarely been used in squint operations, although one well-known American empiric gained much credit with, and considerable gold from, his clients by advertizing to cure squint "without the use of the knife." There is, however, an instrument known as Guthrie's strabismus knife, pictured in this text.

Guthrie's Strabismus Knife.

Strabismus, Latent. That which occurs only under special conditions · *heterophoria.*

Strabismus, Mechanic. That due to pressure or traction on the eye, as by a tumor, producing deflection.

Strabismus, Monocular. The usual form of squint, which always appears in the same eye.

Strabismus needle. See p. 8291, Vol. XI of this *Encyclopedia.* Of the numerous devices of the kind one of the best is Woodruff's. See the accompanying figure.

Woodruff's Strabismus Needle.

Strabismus, Non-concomitant. That in which the amount of deviation of the squinting eye varies according to the direction in which the eyes are turned.

Strabismus, Operations for. See p. 8153, Vol. XI of this *Encyclopedia.*

Strabismus, Paralytic. See p. 8936, Vol. XII of this *Encyclopedia.*

Strabismus, Periodic. Occasional squint; generally the precursor of permanent strabismus.

Strabismus, Permanent alternating. The form in which the deviation shows constantly in one or other eye.

Strabismus, Permanent monocular. The ordinary form of concomitant squint.

Strabismus, Relative. That which occurs for some and not for other distances of the fixation point.

Strabismus, Spastic. Paralytic squint. See **Spastic strabismus.**

Strabismus, Suppressed. An expression for *heterophoria.*

Strabismus sursumvergens. Sursumvergent squint. That in which the visual axis of the squinting eye falls below the fixation point of the other eye.

Strabisometer. An instrument for the measurement of strabismus. See **Strabismometer.**

Strabometer. See **Strabismometer.**

Strabometry. The art and science of measuring the amount of strabismus.

Strabositas. (L.) An old synonym of strabismus.

Strabotome. A knife for performing a squint operation.

Strabotomy. The cutting of an ocular tendon for strabismus.

Strachan's disease. Pellagra.

Strahlenbrechung. (G.) Refraction.

Strahlenbüschel. (G.) Pencil of rays.

Strahlengang. (G.) Path of the ray.

Strahlenkörper. (G.) Ciliary body.

Strahlenkranz. (G.) Corona ciliaris.

Strain, Eye. See p. 5126, Vol. VII of this *Encyclopedia.*

Stramonine. (F.) Datura stramonium.

Stramonium seed. See p. 3750, Vol. V, as well as **Toxic amblyopia** of this *Encyclopedia.* Edward Jackson believes that we might with beneficial effect use *daturin* as an effective substitute for atropia, especially in refraction work, since "jimson weed" is a plant widely and profusely distributed all over the United States.

An occasional cause of amblyopia is the smoking of stramonium leaves (Lewin and Guillery, *Die Wirkungen von Giften auf das Auge,* Vol. I, 198).

Strang. (G.) Column; tract.

Strangulation may be defined as an act of violence in which constriction is applied directly to the neck, either around it or in the forepart, in such a way as to destroy life. This definition obviously includes hanging, which differs from other forms of strangulation only in that the body is suspended. The direct cause of death in the great majority of cases is arrest of the respiration owing to pressure on the windpipe, i. e., asphyxia. If much violence is used, it may be produced by direct injury to the upper part of the spinal cord from fracture or dislocation of the cervical vertebræ (as is now the rule in execution by hanging). On the other hand, if the constriction is so applied as to compress the great vessels in the neck and not the windpipe, as may happen in "garotting," it is due to coma, and is somewhat slower than in cases of asphyxia. Or if both vessels and windpipe are compressed, coma and asphyxia may both contribute to cause death. (*Standard Encyclopedia.*) See *Ocular indications of hanging,* under **Ophthalmology, Legal relations of.**

Strap gauge. See **Eyeglasses and spectacles, Adjustment of,** Vol. VII of this *Encyclopedia.*

Straps. See p. 4954, Vol. VII of this *Encyclopedia..*

Stratum granulosum. 1. The innermost but one of the four layers of the epidermis. 2. Either one of the granular layers of the retina. 3. One of the layers of the cortex of the cerebellum. See **Retina.** 4. The layer of dentin of a tooth immediately beneath the cement.

Stratum opticum. The middle or second, of the three layers of the corpus quadrigeminum.

Stratum pigmenti retinæ. The outer pigment layer of the retina.

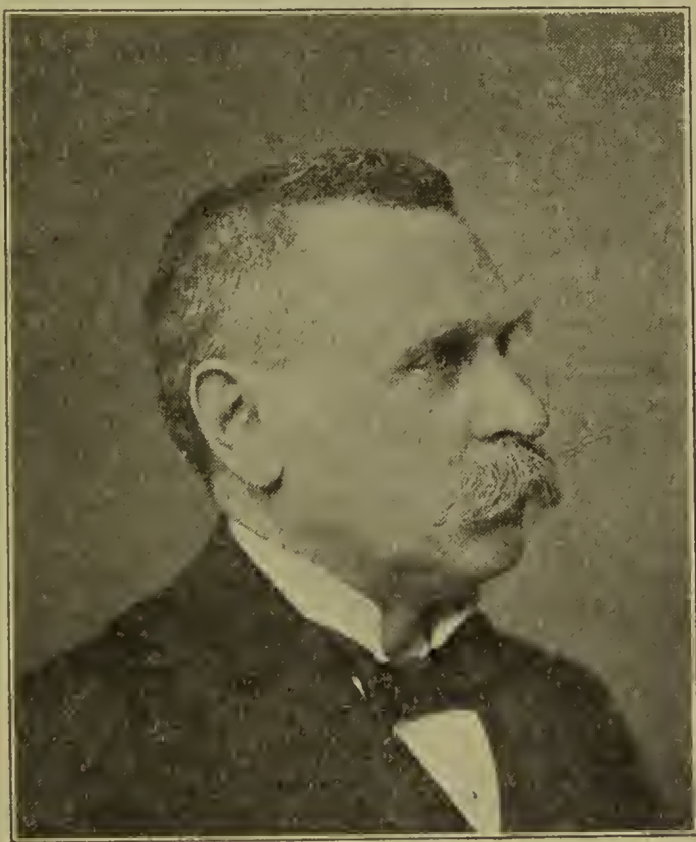
Straub, Dr. A well-known ophthalmologist of Amsterdam, Holland. The date and place of his birth could not be learned. It is known, however, that he was for years a surgeon with the rank of major in the Netherlands army. In 1895 he was made professor of ophthalmology at Amsterdam, where he died, April 14, 1916, after a long illness. The body was cremated, the services being attended by savants from various parts of Holland and even from other countries.

Professor Straub published almost innumerable articles, which, obviously, cannot here be listed. The most important dealt with conjunctivitis, keratitis, the pathology of the ciliary body and the vitreous humor, refraction, and the psychology of vision.—(T. H. S.)

Strawbridge, George. A widely celebrated ophthalmologist of Philadelphia, Pennsylvania. He was born at Philadelphia, Oct. 18, 1844, of Dutch ancestry, his parents being George and Jane V. West Strawbridge. His bachelorship in arts was received at the University of Pennsylvania in 1862, and his medical degree at the same institution in 1865. For the next three years he studied ophthalmology and laryngology at Vienna, Heidelberg, and Berlin.

In 1868 he settled at Philadelphia as ophthalmologist and oto-laryngologist and soon was widely known as operator, teacher and writer. From 1873-1899 he was lecturer on ophthalmology and otology at the University of Pennsylvania. He was also oculist and aurist to the Philadelphia Dispensary, surgeon to the Wills Eye Hospital, ophthalmologist to the Presbyterian Hospital, surgeon in charge of the Pennsylvania Eye and Ear Hospital, etc. He was a fellow of the College of Physicians of Philadelphia, a member of the American Ophthalmological Society, and of the American Otological Society, and in 1876 was a delegate to the International Medical Congress. He was also a member of numerous foreign ophthalmological and otological societies. The list of his contributions to ophthalmology is much too long for insertion here.

Dr. Strawbridge was a man of medium height and broad build. He wore, as a rule, a mustache, had a fair complexion and sky blue eyes. He was gay and brisk in manner, prompt and very decided. He was fond of dogs and horses, and was an excellent horseman. He was a Republican, a member of the Episcopal church, and, in the words of an intimate friend, "a most cheerful Christian and firm believer in a future life."



George Strawbridge.

He married, on June 5, 1873, Alice, daughter of John Welsh, of Philadelphia. To the union were born seven children. Of these three died in early childhood. The remaining four are as follows: John, Capt. Field Artillery, U. S. N. A. (formerly banker and broker), Mary Lowber (wife of Dr. Joseph Sailer, of Philadelphia, now Major, U. S. M. R. C.), Welsh (banker and broker), and Ann West (unmarried.

Dr. Strawbridge died at Philadelphia on June 28, 1914.—(T. H. S.)

Streaks, Angioid. In addition to the observations on p. 465, Vol. 1 of this *Encyclopedia,* Bayer (*Oph. Year-Book,* p. 226, 1913) reports two cases in a woman of 38 and a man of 41. In both cases the pig-

ment streaks formed an irregular circle around each optic disk, from which branches extended in three to six different directions, with the changes in the appearance of the adjoining fundus. In one case several hemorrhages were seen, and in one eye a hemorrhage or vessel having the shape of the streaks.

Bayer discusses the various explanations offered, and having examined one of Magitot's slides disagrees with his conclusion that no vessels are present. In reviewing this paper Coats makes the suggestion that these streaks may arise along vessels, but that the vessels belong to the choroid rather than to the retina. He points out that disease of the choroid seems to be present in nearly every case; while disease confined to the retina has been rarely observed. The pigment favors a choroidal origin. The hemorrhage appears to be deep. In many ways the streaks suggest vessels which may be partially or completely concealed by the heaping up of the pigment along their course.

Streaks, Knapp's. Lines resembling blood-vessels seen occasionally in the retina after hemorrhage.

Streaks, Purkinje's. An appearance seen by Purkinje while looking at a glowing sponge in the darkness. When the image of the sponge lay on the inner side of the point of fixation, there appeared two horns running transversely outward from the margin of the illuminating image, with the convexities upward and downward, so as to inclose an ellipse between the object and the entrance of the optic nerve.

Streatfeild, John Fremlyn. A celebrated English ophthalmologist, for a long time editor of the *Royal London Ophthalmic Hospital Reports* and one of the founders of the British Ophthalmological Society. Born Oct. 14, 1828, at Chart's Edge, Westerham, Kent, he studied at the London Hospital, where he was one of the private pupils of Curling; and in 1852 became an M. R. C. S. Having served for a time in the Crimean War, he devoted himself exclusively, after his return to London, to diseases of the eye. He became at once assistant surgeon at Moorfields, and in 1862 F. R. C. S. A short time afterward. he was made ophthalmic surgeon at the University College Hospital and professor of clinical ophthalmic surgery at University College. Still later he was senior surgeon at Moorfields. He was a good talker, a poor writer, an excellent operator. He died, after a brief illness from pneumonia, Mar. 8, 1886.

Most of Streatfeild's writings are to be found in the *R. L. O. H. Reports*. Some, however, were contributed to the *Lancet*, to Erichsen's "*Surgery*," and to Quain's "*Dictionary of Medicine*." [One of the most important refers to a special operation for *enucleation* of the eye (*Lancet*, p. 849, 1872)]—(T. H. S.)

Streblosis. The angle through which it is necessary to rotate an element of a figure to bring it into coincidence with the corresponding element of a given conformable figure.

Streifenkeratitis. (G.) Striate opacity of the cornea. See **Band-shaped keratitis,** p. 877, Vol. II of this *Encyclopedia.*

Strempel, Karl Friedrich. A well known German internist, who was active in ophthalmology. Born at Bössow, Mecklenburg, Aug. 20, 1800, he received his medical degree at Berlin in 1822, practised at Schwerin and Rostock, where, in 1826, he was made professor of medicine. He wrote a number of works of a general character, but, on ophthalmology, only the introduction to F. Keil's *"Das Schielen und dessen Heilung nach Dieffenbach's Erfindung"* (2d ed., 1841). He seems himself to have performed a rather large number of strabismus operations, but not with any high degree of success. He died at Ludwigslust, Aug. 29, 1872.—(T. H. S.)

Strepto-bacterin. This is really a trade name, although the word *bacterin* is a well known term in bacteriology. See p. 761, Vol. I of this *Encyclopedia.*

Streptococcus. A name given by Billroth to a micrococcus forming with other micrococci chaplet-like chains. In Saccardo's system, it is distinguished as a genus from *micrococcus,* not only by the moniliform threads, but especially by the presence of arthrospores instead of endospores. Many of the numerous varieties or species are microorganisms of great interest to the ophthalmologist; and they are often mentioned and discussed in the pages of this work. See, e. g., p. 784, Vol. I; p. 4021, Vol. VI, and pp. 3501 and 3135, Vol. V. For the treatment of the various streptococcus invasions consult the appropriate headings under the names of the organs attacked.

In addition to the matter found under these captions the rubrics following this heading may be instructive. See, also, corresponding **Bacillus** headings.

Streptococcus brevis. A form sometimes found in inflammatory states of the buccal mucous membrane whence migration to the eye may take place directly or indirectly. See Lewin and Guillery, *Giften auf das Auge,* Vol. 2, p. 9.

Streptococcus conglomeratus. This species is pathogenic for the eye and is found in scarlet fever patients.

Streptococcus erysipelatis. See **Bacillus of erysipelas.**

Streptococcus hemolyticus. Our first knowledge of the pathogenity of this microorganism for the eye was derived from the animal experiments of Brown, Irons and Nadler (*Arch. Ophthal.,* p. 229, May, 1916). These were made with the idea of tracing the changes in the power of

an organism which presumably had already given rise to iridocyclitis in a patient to produce similar lesions in animals, after varying periods of residence in the original host, of residence in animal tissues, and of growth on culture media.

Cultures of hemolytic streptococci, obtained from the tear sac of a patient, were injected intravenously into rabbits. Cultures taken during an acute inflammation produced iridocyclitis in two of four rabbits. Cultures taken subsequently, during a period of continued improvement, produced no lesions of the eye in a total of twenty-two rabbits, but produced equally severe general infections, killing the rabbits in about the same time as the cultures used in the first series. Cultures which had produced ocular lesions in the rabbits and had then been kept in the incubator for ten days no longer produced eye lesions.

F. Park Lewis showed (*Journ. Am. Med. Assocn.*, p. 1813, June 15, 1918) that a retinal hemorrhage in a woman of middle age and in a man aged 70, was probably due to the presence of this organism (in the first instance) in antral pus and in the second case in an infected tooth. The symptom was relieved on treatment by appropriate vaccines.

Streptococcus longus. A name given to many bacilli. They are non motile and occur as cocci in long chains.

Streptococcus mucosus. A capsulated species that occasionally attacks the eye.

Streptococcus murisepticus. See p. 740, Vol. I of this *Encyclopedia.*

Streptococcus pyogenes. This species, which includes the subspecies *S. pyogenes aureus, albus and citreus*, is pathogenic and often affects the ocular organs. Weeks (*Diseases of the Eye*, p. 228) remarks that while *streptococcus pyogenes conjunctivitis* is rare it does occur, is the cause of some forms of membranous conjunctivitis and is not infrequently associated with dacryocystitis, impetigo and lid abscess. Sight may be lost from implication of the cornea.

Streptococcus septopyemicus. This is a virulent form which has been found in the eye. See Lewin and Guillery (*l. c., supra*), Vol. II, p. 9.

Streptococcus serum. Streptococcus vaccine. Among the recent streptococcus vaccines put on the market is that produced by the Lederle Antitoxin Laboratories (*Journ. Am. Med. Assocn.*, p. 1136, April 19, 1919), and thus described: *Streptococcus vaccine (polyvalent)*. Marketed in 10 cc. and 20 cc. vials; in packages of four 1-cc. vials containing, respectively, 50, 100, 200 and 400 million killed streptococci; and in packages of four syringes containing, respectively, 50, 100, 200 and 400 million killed streptococci. See **Seropathy**.

Streptococcus viridans. A species found in some cases of endocarditis and suspected of occasionally attacking the eye.

Streptcthrix dassonvillei. See **Conjunctivitis from nocardia dassonvillei**; p. 3106, Vol. IV of this *Encyclopedia.*

Streptcthrix-Foerster. This is the name formerly given to the fungus found in concretions taken from the lachrymal canals. It was, in some cases at least, the ray-fungus, or *actinomyces* (q. v.). See p. 2284, Vol. III of this *Encyclopedia.*

Streptothrix of the eye. OCULAR NOCARDIASIS. TRICHONOCARDIASIS OF THE OCULAR STRUCTURES. In addition to the matter found under **Actinomycosis of the ocular structures,** p. 84, Vol. I; p. 3106, and on p. 1374, Vol. II of this *Encyclopedia,* it may be said that the hyphomycetous fungi occasionally (but rarely) affect the eye structures.

Of the many changes in classification of these fungi it may be noted that by some authorities the *Streptothrices* are regarded as belonging to a group of trichomyectes intermediate between the bacteria and the higher fungi that includes *actinomyces, leptothrix, cladothrix* and *nocardia,* all of which are described under their appropriate headings in this *Encyclopedia.*

George Coats (*Oph. Record,* p. 281, Sept., 1913) in commenting on the paper of R. Wissmann (*Klin. Monatsbl. f. Augenh.,* p. 287, 1913) says that the first clinical description of *fungus concretions* (*streptothrices*) *in the canaliculus* was given by v. Graefe. The discovery of the fungus itself belongs to a later date, and the problem of its exact classification may be regarded as not yet finally solved.

Wissmann reports the case of a woman, aged 63, who came to the clinic on account of a corneal ulcer which followed a blow with a piece of coal. In the region of the upper canaliculus there was a rather hard swelling about the size of the lens; the punctum was patent, and a yellow, purulent fluid regurgitated from it on pressure. On slitting the canaliculus a yellow, granular mass without adhesion to the wall, was removed. A piece of the posterior wall of the canaliculus was excised for examination.

Smears showed the mass to be composed of an entanglement of fine filaments, variable in length, sometimes rather sinuous, often swollen at the ends. There was no true dichotomous division of the ends of the filaments, but branches were given off from the stem. Staining was most successful by Gram's method, and was frequently uneven, giving an appearance as if the fungus consisted of a linear arrangement of rods or round bodies, but in reality these more deeply-stained portions were not separable from the filaments.

A pure culture was obtained only with difficulty. The fungus was an obligatory anaërobe, and grew only at 37° C. On glycerin agar after an interval of from six to eight days, small, round, feathery-edged colonies appeared. They were fairly transparent at first, but became more opaque later; adhered but little to the culture medium, in which they caused slight liquefaction; and had a dull, moist surface. Growth was very slow, and equal in all directions. In stab cultures small colonies appeared after some time in the vicinity of the puncture, but the surrounding agar remained clear. A loose white deposit was formed in grape sugar bouillon. On gelatin, potato, and milk there was no growth.

In microscopical preparations from the cultures the fungus showed no movement. There was much morphological variation according to the medium in which it had been grown and the age of the culture. On solid media it formed relatively short threads, in fluid cultures filamentary forms were better developed, and in later stages the irregularities of staining and formation of rod and coccus-like bodies already mentioned, became prominent.

Intra-peritoneal injection of the fungus in the mouse and guinea-pig were without effect. Subcutaneously it produced an abscess from which the saprophyte could be recovered. Injected into the eye of a rabbit it slowly proliferated and gave rise to a plastic inflammation, but without showing any tendency to invade the tissues. In the excised pieces of canaliculus also there was round cell infiltration and degeneration of the epithelium, but no invasion.

Wissmann points out that the pathological diagnosis has varied, but that the morphological and cultural characters of the fungus, in the great majority of cases, have been similar or identical. The earliest authors spoke of it as allied to the parasite of favus; then for a while the diagnosis of leptothrix buccalis held the field, to be followed by that of actinomycosis. The most recent authorities, however, classify it as a streptothrix, and to this view Wissmann gives his adhesion, founding his opinion chiefly on the manner in which the fungus branches, whereas a leptothrix is unbranched. The relation between actinomyces and streptothrix is probably close, but Wissmann considers that the former term should be used only when the well-known radiate bodies can be demonstrated, which is very rarely the case in concretions of the canaliculus. The comparative mildness of the affection also, and the absence of invasion of the tissues are not what might be expected in cases of actinomycosis. It appears, however, that the streptothrix, although not so virulent as actinomyces, yet produces more severe lesions elsewhere in the body than in the canaliculus: pos-

sibly it is a special variety which invades the lacrimal passages, or it may be that the thick epithelium affords a protection.

Calderaro has investigated the action of streptothrix in the eye, particularly with reference to the keratitis of harvesters, (*Clinica Oculistica di Roma,* Jan.-Feb., 1913.) He believes that on the ends of beards of grain and in the top branches of many trees (known as causative agents in hypopyon keratitis) streptothrix is frequently found during the time of harvest, and in some localities various species of this organism may be met. These microorganisms occur also in the healthy conjunctivæ of harvesters, and in the conjunctiva of the sound eye of individuals affected in the other eye with the keratitis of harvesters. In one case of keratitis, sixteen hours after the injury by the beard, he isolated a streptothrix which disappeared and was not found in the successive examinations; after the third day the presence of the pneumococcus alone was demonstrated.

Streptothrix, in regard to its virulence in the eyes of animals, may be divided into three groups: First, to which belongs *streptothrix alba;* this form is the most usual met and behaves as an innocuous saprophyte; second, to which belong a few species of the *streptothrix cromogena,* that possess moderate virulence for the different parts of the eye; third, including the genera *streptothrix cromogena* and *violacea,* both of which are capable of producing the most serious changes in the eye that end finally in panophthalmitis.

Experimental infection of the cornea with streptothrix, virulent or not, is supplanted by infection with the pneumococcus or other pyogenic germs that are found or have been deposited by experiment in the conjunctiva.

The presence of virulent streptothrix in a traumatic corneal lesion produces a propitious soil for infection by pneumococcus and increases its virulence. The tips of the beards that remain in the epithelium and in the corneal parenchyma retard the cure of the smallest wound produced by this means, and prepare a most favorable soil for the development of pyogenic germs; for this reason corneal wounds that are not easily visible, received during the time of harvest, produce hypopyon keratitis.

Stretching, Nerve, in glaucoma. For the relief of pain in absolute glaucoma Brailey (*British Med. Journ.,* Oct. 10, 1885) has resorted successfully to stretching of the supratrochlear nerve.

Stria. An imperfection in the shape of a line or band; a streak.

Striæ, Knapp's. Streaks sometimes seen in the retina after hemorrhage. See **Streaks, Angioid.**

Striæ retinales. Under this title Oeller [*Atlas*; see, also, Kröner (*Archiv f. Augenheilkunde*, Vol. 56, pt. 3, p. 263)] has pictured very long, white, and regularly broad streaks in the retina. These are sometimes pigmented on their borders and are apparently elevated. They are regarded as the result of an imperfectly reattached separation of the retina.

Striate cataract. A cortical cataract in which there are many fine streaks and stripes; a common form of immature senile cataract.

Striate clearing. See **Striate opacity.**

Striate clearing of corneal scars. Under this title Sydney Stephenson (*Ophthalmoscope*, p. 440, Sept., 1915), describes a rare metamor-

Striate Clearing of Corneal Cicatrices. Case I. (Stephenson.)

phosis of corneal scars first reported by E. Fuchs (*Beiträge z. Augenheilk.*, Vol. II, p. 1, 1895), who divides these changes into three classes: (1) The cicatrix is divided into polygonal, triangular, or square areas. or into more complicated figures, by the striæ; (2) A star-shaped figure results from a radial disposition of the light lines; and (3) An arc or bow-shaped area is produced by the striæ, encircling a marked central opacity, or the cicatrix is traversed by the striæ, which do not admit of any precise arrangement.

Fuchs laid stress upon the fact that the striate appearance of a corneal opacity always indicated that the scar had lasted a long time. Most of the cases were observed in elderly people, in whom the cicatrices had originated in childhood or youth, and therein lay the diagnostic value of the appearance.

Stephenson reports two cases, and remarks that in Case II (see the figure) the changes are on a much coarser scale than those depicted in Case I. The latter may be termed "fine striate clearing,"

Striate Clearing of Corneal Cicatrices. Case II. (Stephenson.)

and the former "coarse striate clearing" of corneal scars. The cause of the corneal opacity in the first case was interstitial keratitis (inher-

Striate Clearing of Corneal Cicatrices. Case III. (Stephenson.)

ited syphilis), and in the second repeated attacks of phlyctenulosis in comparatively early life Evidently, therefore, the existence of the striæ had nothing whatever to do with the cause of the leucomata. In

both cases the corneal condition was of long-standing, and in neither did the striate clearing show any obvious change while the patients remained under personal observation.

The clear lines, more especially in the first case, remind one of blood-vessels, and it is probable that such were present when the opacity was recent. The present condition has likely followed the more or less complete resorption of the vessels, but inasmuch as many of the striæ are wider than any corneal vessel, there has almost certainly been some clearing of the opacity in the vicinity of the vascular streams. The writer adds that it is quite possible that the striate metamorphosis is commoner than is at present suspected, for it may be overlooked in the absence of a careful examination, as in the left eye of the second patient. See the figure.

Striate keratitis. See **Keratitis, Striped,** p. 6813, Vol. VIII of this *Encyclopedia.*

Striate opacity of the cornea. See p. 877, Vol. II and p. 6813, Vol. IX of this *Encyclopedia.*

Striate retinitis. See **Retinitis striata.**

Stricker, Wilhelm. A celebrated German physician and medical historian, who devoted considerable attention to ophthalmology. Born June 7, 1816, at Frankfort a. m., he studied at Dresden, Göttingen and Berlin, at the last center receiving his medical degree. For the greater portion of his life, he practised in his native city. He was one of the founders of the ophthalmic institute. For a time he was head librarian of the United Senckenberger Medical Library. He died March 5, 1891.

Stricker's ophthalmologic writings are as follows:

1. *Die Krankheiten des Linsensystems nach Physiol. Grundsätzen. Eine in Brüssel Gekrönte Preisschrift.* (Frankf. 1845.)

2. *Der Ritter. Ein Beitrag zur Geschichte der Augenheilkunde vor 100 Jahren. Drei Bücher.* (*Jour. f. Chir. u. Augenheilk.*, N. F., II.)—(T. H. S.)

Stricturotomy. See p. 6957, Vol. IX of this *Encyclopedia.*

W. R. Thompson (*Texas State Journ. of Med.*, July, 1917) thus describes *stricturotomy in obstructed or occluded nasolachrymal duct:*

First step: Anesthetic. In small children a general anesthetic is necessary. In adults, cocainize thoroughly by first instilling into the conjunctival sac a few drops of 5 per cent. cocain solution at intervals of three minutes for fifteen minutes. With a hypodermic syringe inject into the skin of the lower-upper and nasal portion of the sac a few drops of 1 per cent. cocain solution. Wait five minutes.

Second step: Make a free opening into the lachrymal sac by slitting

the canaliculus with a canaliculus knife. Do not make the mistake of attempting to operate through a small opening into the sac.

Third step: If the case is of long standing, with a large quantity of pus in the sac, the inner wall of the sac should be thoroughly curetted with a Buck's flexible wire ear curette. If the only symptom is an overflow of tears the sac is not to be curetted.

Fourth step: With an Anel syringe some 5 per cent, cocain solution is injected into the duct passing, if possible, the stricture. Wait ten minutes.

Fifth step: With the smallest of Buck's flexible wire ear curettes, handled in the same manner as a lachrymal probe, the nasal duct is traversed. When the curette reaches the stricture some difficulty may be experienced in passing it. Thompson has found that by a twisting or auger-like motion the curette will soon find its way through the stricture into the nose. This curette should be manipulated until it passes smoothly through the entire nasal duct. The next larger curette should be used in the same way, and so on until a curette the size of the normal duct will pass without difficulty. The nasal end of the duct may be freed from redundant tissue by bending the curettes on the flat, pushing the curette into the nasal passage and drawing it back with a quick jerk. The instrument should be rotated until every point is reached.

Sixth step: After the sac and duct have been thoroughly curetted and a free opening into the nose is made a more favorable result is secured by twisting gauze or thread around a small spiral applicator and thoroughly rubbing first the interior of the sac and then the entire length of the lachrymal duct.

It is not contemplated, of course, that this treatment is to take the place of any nasal operation which may be indicated.

Carried out in the manner indicated the writer has found that the opening through the stricture remains patent and the relief to symptoms has been permanent.

Striped keratitis. STRIATE KERATITIS. See p. 6813, Vol. IX of this *Encyclopedia*.

Stroboscope. An instrument on the principle of a zoetrope, for exhibiting the successive phases of movements of bodies, especially of animals.

Stroboscopic discs. Paper discs from 6 to 10 inches in diameter, on which a number of figures are drawn in a circle and at equal distances from each other. Such a disc is placed concentrically upon a second larger and darker disc which has near its margin as many openings as the first disc has figures, and both are fastened by means of a screw

upon one end of a small iron axis. When in use, the observer must stand before a mirror, look through the holes in one disc, and rotate the other rapidly.

Stroma of the cornea. The connective-tissue layer or substantia propria.

Stroma vitreum. The fibers composing the framework of the vitreous body.

Stromeyer, Georg Friedrich Louis. A famous German surgeon, who was the first (unless one admits the claims of the empiric Chevalier Taylor) to propose the section of a muscle as a means of curing cross-eye. Born at Hanover, Germany, Mar. 1, 1804, the son of a well known physician, Christian Friedrich Stromeyer, he received his medical degree at Berlin in 1826. For a number of years, both before and after his graduation, he travelled in Germany, France and England, studying the healing art with the greatest assiduity in a number of universities. In 1838, on the death of Michael Jaeger, he was called to the chair of surgery at the University of Erlangen, a position which he held till 1841. After this he taught and practised in Munich, Freiburg and Kiel. For a number of years he then saw service of the hardest character as surgeon in the Schleswig-Holstein army. In 1876 he celebrated the jubilee (50th anniversary) of his doctorate, and shortly afterward, June 15, 1876, he died.

Stromeyer's most important services, perhaps, were rendered in the field of military surgery. In the domain of ophthalmology, however, he will always be remembered because of his important connection with the strabismus operation. Stromeyer, in 1838, proposed (in his *Beiträge zur Operativen Orthopädike*) the employment of muscular section as a means of treating cross-eye, and even went so far as to perform the operation on a cadaver. Dieffenbach, however, in 1839, reported the case of a boy of seven on whom he had actually performed this operation for an inward squint, in the presence of Jüngken, and with an almost perfect result. The Paris Academy of Sciences divided the Monthyon prize between Stromeyer and Dieffenbach: "To M. Stromeyer for having first proposed the strabismus operation and for having first performed it on the cadaver, and to M. Dieffenbach for having first performed it (and with success) on the living subject." —(T. H. S.)

Strontium salicylate. This drug has been recommended (but rarely) as a substitute for the sodium salt and for the other willow preparations.

Hare (*Text-Book of Prac. Therapeutics,* p. 428) regards the drug as a valuable preparation, because it is not so disagreeable to the taste

as the corresponding salt of sodium; and more important still, it is far less apt to disorder the stomach than salicylic acid itself or any of its other salts. He found it for these reasons very useful in acute articular rheumatism when the progress of the patient was delayed by the inability of his stomach to retain the ordinary antirheumatic remedies. The salicylate of strontium is best given in capsule or cachet, and should always be followed by a draught of milk or water to prevent its coming in contact with the stomach in too concentrated form. The dose is, for all practical purposes, identical with that of the salicylate of sodium.

See, also, the report by M. A. Blankenhorn (*Journ. Am. Med. Assocn.*, p. 331, Jan. 29, 1916).

Strophanthus. A genus of poisonous plants. The seeds of *S. hispidus* and *S. kombe,* both African shrubs, are used, like digitalis, chiefly in cardiac diseases. Dose of the tincture, 1-6 min.; of the extract, ¼-1 grain. The powerful *strophanthin,* a white, crystalline glucosid is used as a heart tonic in doses of $\frac{1}{300}$-$\frac{1}{200}$ grain. The various preparations of these plants have been recommended in a few ocular affections (glaucoma especially) in which there is increased blood-pressure. Rarely, it produces oculotoxic symptoms.

Stroschein flask. Stroschein bottle. This well-known model is the device of Stroschein (*Archiv f. Augenheilk.*, 38, p. 155), a number of which are pictured on p. 6046, Vol. VIII of this *Encyclopedia.*

Strudwick, Edmund. A well-known American surgeon, of chief importance as a lithotomist and gynecologist, but also of a certain interest in ophthalmology. Born in Orange County, North Carolina, Mar. 25, 1802, of an old and highly honored family, he received the degree of M. D. at the University of Pennsylvania in 1824. He performed the operation for lacerated perineum a number of times, and cut for stone on twenty-eight consecutive occasions without a death. Concerning his ophthalmologic activity, we quote the following passage from Kelly's "*Cyclopedia of American Medical Biography,*" II, p. 424: "Scores of operations for cataract were performed by him, according to the now obsolete needle method, without losing an eye. Once as he was driving homeward after a long trip in the country, he saw an old man trudging along, led by a small boy at his side. Dr. Strudwick stopped, ascertained that the man had been blind for twelve years, made him get into his carriage and took him to his (the doctor's) home. One eye was operated on first and the other the next week, sight being restored to each. This case, as did all other similar ones appealed to Dr. Strudwick very greatly."

Strudwick perished, though unintentionally, by his own hand. Tak-

ing by mistake (in 1879, at the age of 77) a fatal dose of atropine from a glass of water "in which the drug had been prepared for hypodermic employment in an emergency," he was soon dead.—(T. H. S.)

Struma, Ocular symptoms of. What was once known as "scrofula" or "struma" is now recognized as modified or attenuated tuberculosis. This fact is emphasized in Harrison Butler's paper (*Br. Med. Journ.*, p. 978, Oct. 18, 1913) in which he discusses the diagnosis and treatment of certain "strumous" (i. e., tuberculous) affections of the eye—especially of phlyctenular disease. He regards Benedict's *"photophobia infantum scrofulosa"* as pathognomonic of this disease. Butler also believes that many cases of so-called "rheumatic" iritis are tuberculous and are best treated by tuberculin, while interstitial keratitis is undoubtedly tuberculous in thirty per cent. of the cases, while the same infection is responsible for most attacks of scleritis.

Strumous keratitis. Phlyctenular keratitis. See, also, **Struma.**

Strumous ophthalmia. Phlyctenular conjunctivitis.

Strümpell's disease. Polio-encephalitis. See p. 10304, Vol. XIV of this *Encyclopedia.*

Strychnin. A white, poisonous, extremely bitter, crystalline alkaloid obtained from nux vomica, (see p. 8394, Vol. XI of this *Encyclopedia*) ignatia and various species of strychnos. The chief salts used are the sulphate, hydrochlorid, nitrate and citrate in doses of from $1/64$ to $1/12$ grain. The subcutaneous dose is $1/60$ to $1/12$ gr.

Fuchs (*Text-Book,* Duane, p. 258) remarks that strychnin was first recommended by Nagel for the treatment of *lesions of the optic nerve.* It exerts an excitant action upon the optic nerve, so that even in normal eyes it produces a slight, although not permanent, increase in the visual acuity and enlargement of the field of vision. For therapeutic purposes a one-half-per-cent. solution, of which a quantity equal to one-half or the whole of the contents of a Pravaz syringe—i. e., as much as 5 mg, ($=1/13$ grain) of strychnin per dose—is injected once a day beneath the skin of the temple. It acts best in disturbance of vision unattended by changes visible with the ophthalmoscope, especially in hysterical and neurasthenic forms which, however, generally afford a good prognosis anyway. In serious lesions of the optic nerve, as in progressive atrophy, we often obtain with it an improvement in the sight and especially an enlargement of the field of vision; but these changes are commonly not permanent.

The *oculotoxic symptoms* are said to be, especially in fatal cases, prominence of the eyes and fixity of the visual axes, especially dur-

ing the convulsions. See **Ophthalmology, Legal relations of,** in middle third of the section.

Tonic doses of strychnin are of use in many cases of heterophoria, and it has been employed hypodermically in ocular pareses.

Sturm's focal interval. In *optics,* the distance between the focal lines of an astigmatic pencil or ray-bundle. See **Astigmatism.**—(C. F. P.)

Stumpfsichtig. (G.) Amblyopic.

Stumpfwinkelig. (G.) Obtuse-angled.

Stützfasern. (G.) Connective-tissue fibres.

St. Vitus's dance. Chorea.

Sty. Stye. Hordeolum. Inflammation of one or more of the sebaceous glands of the eyelids. See p. 6003, Vol. VIII of this *Encyclopedia.*

Stye, Blind. This is a synonym of chalazion, tarsal tumor, or Meibomian cyst fully discussed under these headings. See, also, **Blind stye.**

Stye, Zeissian. Inflammation of a zeissian gland at the edge of the lids.

Styles. These lachrymal devices are described on p. 6954, Vol. IX of this *Encyclopedia.*

Priestley Smith (*Ophthalm. Review,* Sept., 1911) strongly advocates the use of styles in chronic dacryocystitis. He criticizes the increasing frequency with which lachrymal sacs are removed, and he deprecates also the frequent and continued use of probes. For a long time past he has treated nearly all cases of this kind with styles, and in very many the results have been highly satisfactory.

The styles he approves are made from pure (not commercial) silver wire, well annealed, i. e., softened by heat after it is drawn, of three thicknesses, 1.3, 1.5 and 1.7 mm., and of four lengths, 35, 40, 45 and 50 mm. They are bent to the necessary shape at the time of using by means of a "bending-ring" which does not cause scratching. A few leaden probes are used for ascertaining the length and shape of the duct.

The insertion of a style is an operation requiring deliberate and delicate manipulation. The more slowly the several steps are effected, the less pain there will be. Unless the parts are acutely inflamed and tender it may usually be completed at the first visit. It may occupy as much as half an hour. Anesthesia and detergescence are obtained by injecting into the tear passages small quantities of 2 per cent. cocain to which 1-10 of adrenalin has been added. A small pledget of cotton soaked in this solution is placed in the inner canthus for a few minutes.

The patient is placed on a couch, not on a chair. The lower canal-

iculus is slit with the gutter looking backwards, the sac is entered and emptied by pressure of any contents. The hollow probe carrying the syringe is passed into the sac and a little fluid injected and time allowed for the fluid to act; moderate pressure will then generally cause the probe to enter the bony duct; a little more fluid is injected and then the probe is pushed down to the floor of the nose. The syringe is removed and the sac washed out with weak izol, or other innocuous fluid. A lead probe, smooth and dipped in vaseline, is passed down the whole length of the passage, withdrawn a very little, bent outwards at the canthus and gently removed; this supplies a model for the length of the style.

A suitable style is bent to the required shape, vaselined and pushed into place; the crook should occupy the whole length of the canaliculus and lie hidden in it. The patient keeps the sac empty by gentle finger-pressure; he should return for inspection in a week, earlier if difficulty arises. A style may be worn for a few weeks or many months. If tight at first it soon becomes loose. So long as watering and discharge continue it should be removed occasionally, cleaned, and reinserted, or replaced by a thick one. Being unseen and unfelt, it is sometimes practically forgotten and worn much longer than necessary—even for years.

While the writer does not give statistics of results, he is convinced that many of his patients—not all—are relieved in this manner, and that the method has advantages over repeated probings, and that it can cure conditions which are now being treated with increasing frequency by destruction of the tear passages.

Sty, Meibomian. Inflammation of a Meibomian gland at the posterior surface of the lid; hordeolum.

Stypticin. See **Cotarnin,** p. 3543, Vol. V of this *Encyclopedia*.

Styptics. See p. 660, Vol. I of this *Encyclopedia*.

Subapical. Situated below the apex.

Subcentral. (a) Being under the centre. (b) Nearly central; a little eccentric.

Subchloride of mercury. See **Calomel,** p. 1367, Vol. II of this *Encyclopedia*.

Subconcave. Slightly concave.

Subconjunctival injections. This important subject has been discussed under various captions of this *Encyclopedia*. See, e. g., p. 1733, Vol. III, p. 3605 and p. 3458, Vol. V; also, under **Retina, Detachment of the.**

Solutions of common salt, bichloride of mercury, cyanide of mercury, etc., are used in a number of affections of the eyeball, as for

example, in *corneal ulcer, iritis, scleritis, choroiditis, retinitis, detached retina,* etc. The conjunctiva should be anesthetized with holocain or cocain, the point of the sterile hypodermic needle inserted near the margin of the cornea, well into the subconjunctival tissue, and a few (3 to 10) drops of the solution injected. The pain is not severe when mild salt, borax or boric acid solutions are employed, but it is quite severe when bichloride, cyanide and strong (5 per cent. to 20 per cent.) sodic chloride preparations are used alone.

Although von Rothmond in 1866 recommended subconjunctival injections, using them for the removal of corneal opacities, to Darier (*Annales d'Oculistique,* 1893, Vol. 109) is due the credit of definitely stating the conditions under which solutions (especially of *mercuric chloride*) can be best employed in this way. He used as strong a mixture as 1:1,000. The eye was cocainized and a syringeful injected beneath the conjunctiva 7 mm. from the sclero-corneal junction. Very little pain or irritation followed and Darier then and since has recommended the bichloride treatment in cases of incipient creeping ulcer, minor degree of parenchymatous keratitis, acute choroidal infiltrations, luetic disease of the eye and infected traumatic lesions. The injections are given daily or less frequently in full or decreasing doses, according to the requirements of the case. Although the use of sublimate and other mercurial remedies was followed by good results in the hands of many other observers it was occasionally noticed that the injections were causing pain and set up serious reactions. For this reason and because it was believed that the value of the subconjunctival injections rests not so much in the specific character of the mercurial employed as in the derivative or stimulating effects upon the lymph and vascular circulation of cornea and eye interior set up by the injection, less irritating salts were employed. The experiments of Mellinger (*Archiv f. Augenheilk.,* 32, p. 79, 1896) showed conclusively that we can with less pain and danger to the patient, obtain from common salt (1:10 per cent. solution) practically all the resolvent effects of mercuric chloride. This safe and painless procedure has been used with some success as an adjunct to the treatment of detached retina, iritis with posterior synechia, all forms of corneal ulcer and in many cases of scleritis. In its turn it will probably, in most cases, have its place in ocular therapeutics taken by *dionin* (q. v.) whose action is, in some respects, similar. The Editor is in the habit of using 1 to 5 per cent. subconjunctival salt injections as a continuation of the treatment by dionin when that drug has ceased to produce the conjunctival edema without which its therapeutic value is practically nil.

Darier (*Thérapeutique Oculaire,* p. 32) in addition to its employ-

ment in hypodermic and intravenous injections (0.06 to 0.08 centigramme) advocates the use of enesol subconjunctively, and believes it is likely to replace mercuric cyanide and other salts of mercury for all these purposes. It is less irritating and less painful than they and gives excellent therapeutic results.

T. A. Woodruff (Wood's *System of Oph. Therapeutics*) advises the following mixture as an efficient remedy in corneal ulcer, iritis, etc., as less irritating than, and often quite as effective as, salt and mercurial preparations; Iodin, gr. 1/7; potass. iodide, gr. j; distilled water, one fld. ounce.

After unsuccessfully treating a case of parenchymatous keratitis with subconjunctival injections of sodium chlorid, Thienpondt (*Oph. Year-Book*, p. 34, 1913) tried the effect of injections of magnesium sulphate. On the first day, but more particularly on the second day, after the injection, a marked clearing of the cornea had occurred. Further comparative injections of sodium chlorid produced no result, whereas subsequent doses of magnesium sulphate were again followed by notable clearing. The dose used was 1 cm. of a 4 per cent. solution. Equally good results were obtained from injections of sodium sulphate. Thienpondt concludes that these two drugs are superior to sodium chlorid for subconjunctival injections.

Darier injected a 2 per cent. aqueous solution of neosalvarsan beneath the conjunctiva in eleven miscellaneous cases of eye disease. He speaks doubtfully of three as the number of cases which were "possibly" benefited by the treatment.

Schiele has used solutions of sodium iodate 1:500 to 1:1000, half a syringeful, to which a drop of a 1 per cent. solution of acoin is added to diminish pain. Its principal value is analgesic, relieving the pain of iritis, cyclitis, panophthalmitis, or glaucoma. The injections are also supposed to have a direct curative effect. Darier reports favorably upon them, having tried them in 11 cases of secondary glaucoma.

For *subconjunctival injections of syrgol*, see **Syrgol.**

F. Verderame (*Annali di Ottalm.*, 42, p. 73, 1913) describes the effects of subconjunctival injections of chloride of sodium on the ocular tension in man. The tests were made on three series of eyes, with normal, increased and lowered tension, respectively. Two, three and four per cent. solutions of sodium chloride were used, in quantities of 0.5 and 1 ccm. The injections were made under holocain, and after preliminary measurement of the tension. The tension was again measured at once, or after from 30 to 60 minutes, and further measurements were made on the same and successive days. The first series of experiments included 24 eyes with normal tension. Almost without

exception the injection produced a rise of tension, which varied from 2 to 7 millimeters of mercury. The increase of tension was greater with the more concentrated solutions, and also with the injection of larger doses. Immediately after the injection there was no appreciable change in the tension. A distinct rise was noticed after one hour, and the increase steadily continued for a further period of from two to four hours. After this there was a gradual fall, the original tension being reached at the end of eight or ten hours. In one or two instances the tension twenty-four hours after the injection was very slightly lower than in the first place.

The increase of tension cannot very well be explained by the mechanical effect of the introduction of the salt solution under the conjunctiva; since in such case the rise should be found immediately after injection. The gradual increase seems to confirm Wessely's theory, that subconjunctival injections exert a powerful stimulus on the ciliary body, thus tending to increase the ciliary secretion, and in this way the intraocular tension.

The greatest increase of tension. tested in the same individual. was obtained when the injection was made close to the limbus, and the least when the injection was made posteriorly in Tenon's space. In some cases repeated injections caused a marked weakening of the effect as regards increase of ocular tension.

The next series of tests included two hydrophthalmic eyes, six eyes affected with inflammatory glaucoma, and four with glaucoma simplex. In these the results were generally similar to those obtained in normal eyes. The rise of tension produced varied from 4 to 15 mm. of mercury. In two cases of inflammatory glaucoma the increase of tension was followed by a respective lowering of 2.5 and 3 mm. below the primary reading. But in these and the other glaucomatous cases, the use of miotics produced a much more decided drop than that secondarily resulting from the subconjunctival injections. In one instance a typical glaucomatous attack followed the injection of 0.5 ccm. of a 3 per cent. solution of sodium chloride, the tension rising from 48 to 62.5 mm. of Hg. In glaucoma simplex there was a notable fall of tension, which was preceded, however, by a rise, and lasted only forty-eight hours. In these cases also the action of miotics was more marked than that of the injections.

The effect of the injections was also studied on seventeen eyes with retinal detachment and subnormal tension. In nearly every case there was a rise of tension, which reached its maximum four to six hours after the injection, and fell again to the original level some hours later. Here again greater concentration or larger dosage produced a more

marked effect. In some instances, after repeated injections, there was a slight persistent rise of tension which lasted for several days.

Subconjunctival injections of salt solution, therefore, seem to be indicated in those cases of retinal detachment in which it is important to promote the absorption of exudate lying behind the retina. For this purpose the treatment should be repeated at relatively short intervals.

A study of the cytochemistry of the aqueous humor in eye diseases from the effect of subconjunctival injections has been made by Stanculeanu (*La Clinique d'Ophtal.*, Nov., 1914; reviewed in *Annals of Ophthalm.*, p. 152, 1916). He used the method of y Troncoso and found in glaucoma, inflammatory and simple, an increase both in organic and mineral matter. In parenchymatous keratitis with increased tension the analysis was similar to glaucoma, but in hypotension the normal findings presented. The early stage of iritis has increased volume of the organic substances. Cases of cataract and sympathetic ophthalmia approach normal percentages. In albuminuric retinitis there is an increase of the organic content without increase in tension, showing that glaucoma is not due to impermeability to the filtration of albuminous substances. Injections of cyanid of mercury increased the albumin in the aqueous, none of the drug being found, and thus the conclusion that salvarsan and other substances reach the eye quicker from intravenous use. Sodium chlorid ten per cent. increased the albumin, but to a less degree than the cyanid. Sodium iodid ten per cent. passed into the aqueous faster and in greater quantity than when given by any other method.

Erb (*Prac. Med. Series*, Eye, p. 195, 1908) has found that subconjunctival injections of from 2 to 5 per cent. solutions of salt may be painlessly made by instilling into the conjunctival sac a few drops of a 10 per cent. solution of dionin, followed in about two minutes' time by a few drops of a 4 per cent. solution of cocain. He is unable to decide whether this result is secured through the anesthesia or the edema (similar to infiltration anesthesia) produced by the dionin.

H. W. Woodruff (*Texas State Jour. Med.*, September, 1914) discusses the use of various drugs and the strengths used in subconjunctival injections. He reports five cases treated by this means and concludes as follows: (1) Subconjunctival injections have a limited sphere of usefulness. In all chronic conditions, such as optic nerve atrophy, leucoma of the cornea and detached retina, they have not been proven of any value. (2) A subconjunctival injection of any soluble substance, except adrenalin, eserin and pilocarpin, will cause a temporary rise in tension and therefore should not be used in glaucoma. (3) In acute purulent processes of the anterior segment of the

globe, subconjunctival injections of cyanide of mercury are effective if used early. At the present time no other known treatment will so rapidly bring about resolution.

After washing and disinfecting the parts, injections are made in cases of kerato-hypopyon by Maggi (*Annali di Ottalmologia,* 3 and 4, 1907) with a sterilized syringe and a boiled solution after instilling a few drops of cocain into the conjunctival sac. Each time—every 5 to 8 days—two injections were made of .5 c.c., one in the superior and the other in the inferior conjunctiva a few mm. from the limbus. Bichlorid of quinin, 1 to 400, sublimate, 1 to 5000, and chlorid of sodium to 0.75 were the solutions used. He details many cases but one of each will suffice.

Injections of bichlorid of quinin. Corneal ulcer with slight infiltration, hypopyon of almost half of anterior chamber. Injection given, hypopyon undiminished in quantity, but more fluid. Next day, hypopyon, still more fluid and diminished in quantity, ulcer small. This improvement continued and after 8 days no trace of hypopyon, ulcer practically healed.

Injection of bichlorid of mercury. Central corneal ulcer, with hypopyon of one-quarter of anterior chamber, immobile. May 31, injection. June 1, intense edema and chemosis of lower conjunctiva, no change in hypopyon. Cornea infiltrated superficially. June 2, edema of entire conjunctiva almost covering cornea. June 3, edema less. June 4, conjunctival ring covering cornea less, conjunctiva less injected, ulcer larger, hypopyon denser and increased. June 6, ulcer stationary, hypopyon still slightly increased. On following days hypopyon slowly increased until July 10, when it occupied half of the anterior chamber. It finally had to be removed by paracentesis, after which it did not recur. The ulcer improved slowly.

Injection of chlorid of sodium. Central corneal ulcer, hypopyon one-half of anterior chamber, mobile. April 17, injection. April 18, ulcer large, margins infiltrated, hypopyon increased. April 22, injection. April 23, eye worse. April 25, cornea wholly infiltrated, ulcer more extensive. Saemisch operation and galvanocautery. From this time hypopyon not reproduced and cornea gradually improved. The writer concludes that quinin is the best injection in this disease.

Subconjunctival injections of mercuric cyanide. As has been several times mentioned, H. W. Woodruff (Wood's *System of Oph. Therapeutics,* p. 73) has given much attention to and highly recommends the Bourgeois plan of subconjunctival injection of mercuric cyanide, especially in *serpent ulcer* and in infections following cataract extraction—indeed, in any severe purulent process involving the eyeball.

The conjunctiva is anesthetized by three or four instillations of 4 per cent. cocain solution during ten or fifteen minutes. Then eight minims of a solution of cyanide of mercury, 1 to 1,000, with four minims of 4 per cent. cocain added [better dissolve the cyanide in one per cent. acoin solution] are injected beneath the internal conjunctival cul-de-sac with the hypodermic syringe. When the needle comes in contact with the external wall of the orbit the point should be turned slightly inward and the needle plunged deeply into the tissues, so that the injection is more than subconjunctival. The tissues of the orbit surrounding the eyeball are bathed with this solution. The swelling and edema which follow are quite severe, but this is probably beneficial rather than harmful. He has used these injections in many cases with signal success.

E. L. Jones (*Journ. of Am. Med. Assocn.*, p. 991, Sept. 21, 1912) invariably uses 2 c.c. (30 m.) of fluid, believing the distention and flushing of the lymph-channels essential to success. Commonly he employs a solution of 1:1,500 mercury cyanid in which is dissolved .5 grains of a powder, one part each acoin and boric acid and four parts salt. Still further to diminish pain he also adds to the injection .125 to .25 gr. each of morphin and dionin. The pain commonly lasts ten or fifteen minutes. The conjunctiva is immediately raised up around the cornea one-fourth inch or more. Swelling rapidly extends to the lids, and frequently to the entire side of the face. It disappears in two to four weeks. The conjunctiva is discolored around the puncture. Each injection is followed by adhesions of the conjunctiva to the sclera over an area as large as a little finger-nail, which subsequently looks white as marble, but causes no limitation or discomfort of movement. The preferable point for injection is between the recti muscles as far back from the cornea as possible. In children the injection may be administered under a general anesthetic, but the same amount should be used as for an adult. This treatment is reserved for eyes otherwise likely to be lost, or which persistently resist milder measures. The twenty-four cases reported include strikingly good results in sympathetic ophthalmia, choroiditis, including cases involving the macula, and of tubercular origin, interstitial keratitis, uveitis with increased tension, glaucoma following retinal hemorrhage, epibulbar scleritis, retrobulbar neuritis, neuritis following salvarsan, injuries and foreign bodies in the eye.

C. B. Meding (*New York State Jour. Med.*, Jan., 1914) reports the results of subconjunctival injection of mercuric cyanide in patients who came under his observation at the Amritsar Hospital, India. The

results coincide with the conclusions of H. W. Woodruff, just given. The condensed report follows:

Condition	Number Injected.	Good Results.	No Results.
Opacities of vitreous	1	1	..
Trachomatous keratitis (pannus)	100	75	3
Ulcers, acute-indolent	40	25	5
Ulcer, hypopyon	3	2	..
Keratitis ulcerosa suppurativa	2	1	..
Corneal opacities (recent?)	28	10	..
Keratitis, parenchymatous	3	1	..
Sympathetic ophthalmia	1	1	..
Episcleritis and scleritis	4	2	1
	182	118	9

In all these cases the treatment consisted of subconjunctival injections of from 10 to 20 minims of a 1 to 4000 solution of the cyanide of mercury in sterile water. Blepharospasm and lachrymation were promptly relieved; pain in scleritis and ulcers ceased; and recent corneal opacities were improved. Untoward accidents, such as necrosis, ecchymosis and injury of sclera were never observed. The author cautions against allowing the needle to engage in Tenon's capsule or injecting too near the limbus. Children seem to stand stronger solutions than the aged, and a warmed solution seems less painful. The cyanide of mercury does not affect instruments. It is as potent as bichloride, yet less irritating and causes less adhesion. Whatever may be the value of salt solution in choroidal, retinal and neural affections it is not to be compared with the cyanide in the above group.

That the subconjunctival use of powerful antiseptics is occasionally followed by disagreeable results is well established. For instance de Schweinitz (*Oph. Record,* p. 165, April, 1907) noted a case of intra-ocular tension following a subconjunctival injection of a solution of mercury cyanide. The patient, a man, 29 years old, had a marked uveitis of the left eye which had begun with a conjunctival hemorrhage, and later a hemorrhage into the vitreous had occurred. His general condition was good. Vision of the left eye, after correction of 1 D. of hyperopic astigmatism with its axis 180 was normal, vision in the left (right?) eye was 6-60, tension below normal, anterior chamber deep, iris discolored and its pupillary area thickened and elevated. There was a fine, punctate keratitis, the vitreous was filled with thick opacities through which the fundus showed dimly, revealing a disk

with blurred margins and very dark, tortuous veins. There was a marked contraction of the visual field on the upper and temporal sides. Scopolamin mydriasis, mercurial inunctions followed by iodide of potassium and pilocarpin diaphoresis gave very satisfactory results, and vision finally rose to 6-20.

C. H. Sattler (*Archiv f. Ophthalm.,* II, Vol. 88) claims that firm adhesions appear between the sclera and conjunctiva on the subconjunctival use of more than 0.1 c.c. of a 1 per cent. acoin solution. Greater doses cause permanent corneal opacities and intense shrinkage of the conjunctiva. Consequently, he emphasizes the statement that more than 0.1 c.c. of a freshly prepared 1 per cent. acoin solution should never be used subconjunctivally.

The Editor has frequently given subconjunctival injections of cyanid of mercury in from 1 to 2,000 to 1 to 4,000 solution, but always with 1-per-cent. acoin, generally beginning with the weakest dose of the cyanid. In serious cases of ocular infection there is, in his opinion, no single remedy equal to it, and when used with discretion, warning the patient there will be a little discomfort and much swelling and redness of the eye, lids and face, there will be much satisfaction derived from its employment. The injection, thus associated with acoin, is almost painless and is given as an office treatment. It sounds trivial to talk about conjunctival areas of adhesion to the sclera as a contra-indication when a remedy is under discussion that may save the patient from blindness.

Subconjunctival injection of sterilized air. The air is sterilized either by suction through a cotton filter or by heating of the needle of the syringe. The amount of air is 2 to 6 cc.; five injections are given at intervals of three days. This treatment, according to Delmiro de Cezalt (*Wien. Med. Wochenschr.,* Mar. 20, 1909) is used only in diseases of the anterior eye, such as affections of the cornea and in episcleritis. The injections diminish the pain, photophobia, lachrymation and blepharospasm. In cases of scleritis and episcleritis the nodules become absorbed. The effect of the injection is explained by the fact that the oxygen of the injected air irritates the anterior ciliary and conjunctival blood-vessels, and an increased leucocytosis takes place. The mechanical effect is also to be considered; by this means the adhesions existing between the connective tissue and the mucous membrane are torn. The forced tension of the conjunctival and episcleral tissues acts also as an analgesic upon the nerve filaments. See, also, p. 199, Vol. I of this *Encyclopedia*.

Robert S. Lamb (*Am. Journ. of Syphilis,* Jan., 1917) has treated one hundred cases of *ocular syphilis* by *subconjunctival injections of*

salvarsanized serum, prepared by the Swift-Ellis method. The results, after three years experience, have been quite satisfactory.

The diseases most commonly found in the patients coming under observation and upon whom the serum was used were—iritis, iridocyclitis, keratoiritis and interstitial keratitis.

Two neuroretinitis cases showed marked response in much shorter time than usual, and whereas the treatment was used conjointly with intravenous salvarsan and Swift-Ellis spinal injections, nevertheless much credit is attributed to the subconjunctival injections for the return of vision to distant vision of $^6/_4$ and J. 1. at 15 inches without glasses, when one eye of one patient on first examination showed no correct vision at any distance for direct vision and only indistinct object vision and perception of light peripherally. As he expressed it he could see a light by looking sidewise at it. The writer uses the following method of preparation: A dose of salvarsan or allied material is given intravenously in the usual manner. At the end of an hour, 50 or 60 or even 100 c.c. of the patient's blood are drawn by means of venous puncture; clear serum thus separated, allowed to stand an hour, then centrifugalized, is diluted to 40 per cent. with normal salt solution, heated to 56° C., for half an hour; then either hermetically sealed in ampules or kept cool until the following day, when it is put in ampules, capacity 1 c.c., and kept on ice a reasonable length of time, to be used whenever needed.

The employment of subconjunctival injections as a *preliminary to cataract extraction and glaucoma operations* is discussed by J. Santos Fernandez (*Cronica Méd-Quir.*, Feb., 1919; abst. *Journ. Am. Med. Assocn.*, Aug. 30, 1919). The writer says that these operations can be done without subconjunctival injection of cocain, but if one wishes to omit nothing that will aid in rendering the operation a success, this is certainly to be recommended. He injects 0.005 gm. of morphin half an hour before the operation and repeats it after the operation, as it is very important to keep the patient in a tranquil frame of mind. To aid in this he does not set a day for the operation, but keeps speaking of preliminary things that have to be done, and the operation can then be performed whenever most convenient and without apprehension on the patient's part.

Subconjunctival reefing. The "jig-saw" operation of Bishop Harman for squint. See p. 8231, Vol. XI of this *Encyclopedia*.

Subconjunctival rupture of the eyeball. An example of this rather unusual accident is reported by Eugene Blake (*Ophthal. Record*, February, 1916). A woman, aged 46, seven weeks previous to consulting the writer slipped and fell, striking her left eye upon the knob of

a chair back. When first seen the eye was white and free from inflammation. There was a translucent, globular swelling about 1 cm. in diameter, situated just above the limbus in the upper and slightly nasal quadrant. The iris was drawn up in this location and presented an appearance as though an iridectomy had been performed. The anterior chamber was very deep, the tension much below normal. The iris was not tremulous, probably because it was so firmly drawn up into the wound. Behind the iris was a blood-clot, preventing any view of the fundus. No trace of a lens could be found either because it was back in the vitreous or because it had previously been absorbed. The eye had once before been struck and sight practically destroyed.

Palpation and transillumination failed to show the presence of the lens in the conjunctival swelling. Vision was reduced to uncertain light perception.

The patient presented the appearance of having a large chalazion in the left upper lid, but upon raising the lid the true condition was recognized. See, also, **Injuries of the eye.**

Subconjunctivitis. The name given by von Graefe to episcleritis partialis fugax. See p. 4498, Vol. VI of this *Encyclopedia.*

Subconvex. Somewhat convex.

Subcutin. ANESTHESIN. This drug is an ethylester of para-amidobenzoic acid and occurs as a white crystalline powder soluble in 100 parts of cold and 40 parts of hot water. As a local anesthetic it is employed—generally in hypodermic form—in twelve and a half per cent. strength, dissolved in physiological salt solution.

Subcylindric. Nearly or somewhat cylindrical.

Subdermal. SUBDERMIC. HYPODERMIC. Beneath the true skin.

Subduction. The act of turning down. See under **Muscles, Ocular,** p. 7978, Vol. X of this *Encyclopedia.*

Sub-enucleation. A partial removal of the eyeball. See the major heading, **Enucleation of the eye and its substitutes.**

Subelliptic. Between ovate or oblong and elliptic.

Subfrontal. Situated under the front, face, or fore-end.

Subhyaloid. Situated beneath the hyaloid membrane.

Subhyaloid hemorrhage. PRERETINAL HEMORRHAGE. Effusion of blood between the retina and vitreous. See p. 5805, Vol. VIII, and p. 10353, Vol. XIII of this *Encyclopedia.*

Subjective magnifying power. See **Magnifying power,** p. 7588, Vol. X of this *Encyclopedia.*

Subjective sensation. A sensation which is not caused by any object exterior to the body.

Subjective symptoms. Those observed by the patient.

Subjectoscope. An instrument used in the study of subjective visual sensations.

Sublamin. This remedy is found as white crystals easily soluble in water and glycerin and contains about 44 per cent. of mercury. In collyria it is usually ordered in 1:5000—3000 solutions.

It is a mercuric ethylenediamine sulphate and is said by Blumberg to have the greatest power of tissue penetration (with the minimum effect upon the skin) of all the mercurial salts. It is less poisonous than corrosive sublimate and its disinfectant quality is at least equal. Furthermore, corrosive sublimate frequently causes eczema of the skin, while sublamin does not. This is important, since exact experimentation has shown that the very slightest roughness, the most significant scaling of the skin, make an efficient disinfection of the parts more and more difficult. In this connection since, as Schleich, Gottstein, Haegler and others have shown, a sterile condition of the hands is the first desideratum in efficient operative work, and for that reason when a mercuric salt is employed for the purpose sublamin, even in concentrated solutions (in which state sublimate cannot be employed at all) is not contraindicated.

Imre (*Die Heilkunde*, Sept., 1903) who made some of the earliest observations of this germicide investigated its value as a conjunctival disinfectant. He found it to be valuable in the various forms of suppurative conjunctivitis. In this connection he reminds us that regular cleansing of the conjunctival surface is the most important element in the treatment of these cases, i. e., everything depends upon the frequent removal of the accumulated secretion. The earlier it is begun the greater is the likelihood that it will save the cornea. But even when begun late, irrigation is of the greatest importance. Though the noxious substances or bacteria under the conjunctiva or even in the corneal tissue cannot under these circumstances be reached by the fluid, it is always essential to prevent their stagnation in the conjunctival sac. In some cases the fluid employed for irrigation is of no consequence; hence in chronic cases such as trachoma a 1 per cent. salt solution suffices. But in more acute cases, with abundant suppuration, as, for example, in gonorrheal conjunctivitis, a bactericidal action is absolutely necessary. Abundant experience led him to affirm without hesitation that the desiccating action of simple irrigation fluids that are neutral as regards temperature and concentration, is by no means equal to that of really bactericidal remedies. Unfortunately, however, there is no direct relationship between disinfectant power and therapeutic action; the sensitiveness of the conjunctiva must be reckoned with and chemical irritants avoided; for increased

secretion in consequence of irritation much more than counterbalances their transitory good effects. Here a 1:1000 sublamin solution answers admirably, being readily borne and hardly causing prickling, redness or mucous secretion in the healthy conjunctiva.

In acute gonorrheal conjunctivitis the instillations were made every half hour from an undine onto the everted lids; where that was not possible the lids were opened as far as this could be done with the fingers or with retractors. Fifty to 100 grams (1½ oz. to 3 ozs.) were used each time, and the treatment kept up day and night. Occasionally the instillations were made oftener, to obviate the stagnation of the pus; but experience has taught that too frequent irrigation, no matter with what, causes the formation of pseudomembranes. So for that matter do all other procedures which occasion too rapid death and desquamation of the epithelial cells, cause hyperemia and fibrinous exudation.

In other cases of severe infectious conjunctivitis, which are often caused by the Koch-Weeks bacillus, and generally in all cases of fresh catarrhs, sublamin compresses and irrigations are more effective than boric acid or the employment of lead or zinc. The secretion disappears more rapidly and the conjunctiva thins quicker. Painting with a weak nitrate of silver solution, or better with argentamin, must not be omitted; otherwise the later stages of the disease, when the violent irritative symptoms have disappeared, may be much protracted.

Sublatio retinæ. Detachment of the retina.

Sublimate. Corrosive sublimate. See **Mercury bichloride,** p. 7651, Vol. X, as well as p. 546, Vol. I, of this *Encyclopedia.* Consult, also, **Subconjunctival injections.**

The toxic effects of this drug are considered under **Toxic amblyopia.** Here may be mentioned the (fortunately) almost unique experience of Aaron Brav (*N. Y. Med. Journ.,* p. 1027, Dec. 1, 1917) with a burn of the eye from the accidental instillation of a stock (7½ grains to 60 minims of water) solution of sublimate into the conjunctival sac.

The writer remarks that this act is followed by severe pain and burning lasting for several days. The pain is almost intolerable the first few hours. It grows less in intensity and finally stops after the third day, although the sensation of burning still continues. The conjunctiva is raised from its bed like a balloon all around the cornea, covering the cornea completely. There is a contraction of all the bloodvessels including the capillaries so that the chemosed conjunctiva is quite pale. The lachrymal gland ceases to function so that the conjunctiva is dry. The dryness lasts for about twenty-four hours;

it is then followed by a relaxation of the bloodvessels, and the conjunctiva again becomes red. The function of the lachrymal gland is reestablished and is stimulated so that there is marked lachrymation. The chemosis of the conjunctiva lasts from six to ten days. The first day it has the appearance of a conjunctiva into which a salt solution has been injected except that the tissues are dry. After the bloodvessels have relaxed, one is reminded of the chemosis seen after insufflation of the dry powder of dionin into the conjunctival sac. The superficial layers of the conjunctiva become necrosed and begin to form a membrane which, thin and delicate in the beginning, becomes thick and tough after the third day. This membrane resembles the diphtheritic membrane; it adheres closely to the conjunctiva for several days and then becomes loose and may be removed in a mass as one layer, leaving a smooth, pale conjunctiva behind. There is no bleeding when this membrane is removed.

On the second day after the accident bands of adhesions begin to form and if proper care is not taken the conjunctiva of the lid becomes agglutinated to the bulbar conjunctiva. The raised conjunctiva of the lower lid becomes agglutinated to the upper lid thus hiding the eyeball. Beneath this agglutination there is a collection of lachrymal fluid. This agglutination may result in firm adhesion. The agglutinated conjunctiva is easily separated without producing any deep ulceration. The chemical reaction of the poison forms an albuminate of mercury which is insoluble. This accounts for the fact that there are no constitutional symptoms present. The effect of the solution is localized. There is, however, a necrotic effect, as the thickened membrane covering both palpebral as well as the bulbar conjunctiva is a mere sloughing of the conjunctival tissues. There is no deep ulceration, as would be expected. The cornea remains clear and unaffected; the cornea is apparently able to resist the corrosive nature of the poison. The corneal epithelium is intact.

The lids are affected. In the beginning there is a serous edema. The lids are baggy and swollen and both upper and lower are involved. The swelling soon extends above the superciliary ridge and downward to the malar bone; at its height it reaches the lower maxillary region. About twelve hours later this swelling becomes tense and red having the appearance of a well developed cellulitis. The infiltrated lid is painful to the touch and is separated with great difficulty and severe pain to the patient. The cellulitis reaches its height about thirty-six hours after the instillation of the chemical poison and then begins to recede. The lids change in color. They are no longer so tense and red, but somewhat soft, wrinkled, and dark-brown in color, looking

like the common traumatic "black eye." They are more yielding to manipulation although still painful because of the agglutination of the conjunctiva and the formation of adhesions. Gentle pressure applied separates them, exposing the raised conjunctiva and its various adhesive bands to the view of the observer. The pain finally subsides after the fifth day. The swelling diminishes and the discoloration disappears within two weeks; the skin of the lid resumes its natural color, the sloughing of the conjunctiva ceases, the redness begins to disappear, and after six weeks of careful treatment the eye, with the exception of some conjunctival contractions, is again in a normal condition.

This favorable result is obtained through rational application of therapeutic measures, without which a great deal of damage would result to the eye either through corneal abrasions, the agglutination of the lower lid to the upper lid, or adhesions from the palpebral to the bulbar conjunctiva that would require surgical interference for relief.

Brav believes that if the accident is discovered immediately after its occurrence it is advisable to flush the eye with milk. In this case the accident was discovered about five hours later when the chemical reaction had already taken place. The chief principle in the treatment is to prevent corneal complication resulting from the dry state of the conjunctiva and the formation of adhesions. This is best accomplished by the frequent instillation of olive oil. Several drops of the oil should be instilled every two hours. This provides a smooth gliding surface for the cornea, keeps the eye moist and minimizes the pain. The iris should be put at rest by the instillation of a one per cent. solution of atropin. In the beginning the physician should see the patient twice daily in order to separate the adhesions that form rapidly and prevent the agglutination of the raised lower conjunctiva to the upper lid. In separating the conjunctival agglutinations care must be taken not to injure the conjunctiva. It is best to use a cotton pledget applicator dipped in oil; a dry applicator should not be used as it will produce ulcerations. The process of breaking up adhesions and separating agglutinated surfaces should not be delegated to the nurse, but should be done by the attending physician, who alone recognizes the seriousness of the case. Externally a very cold antiphlogistic solution should be applied.

The ice bag on top of this solution is essential in reducing pain and giving comfort to the patient. This should be continued for about five or six days. Discontinue the ice bag after the fifth day, fearing the development of necrosis. The external application reduces the swelling and minimizes the pain and the burning sensation which in

the first twenty-four hours is very severe. As soon as the chemosis has subsided so that the lids can be freely opened, the eyes should be irrigated three times daily with a boric acid solution. This acts as a cleansing agent and also has a sedative effect upon the tissues which have become irritated by the increased lachrymation. The olive oil has to be employed for about three to four weeks while sloughing is going on in the conjunctiva. The atropin must be continued until the conjunctival redness disappears and the necrosed conjunctiva has reformed. It takes from six weeks to two months before the eyes are perfectly quiet.

Sublimate is also useful for fixing eye specimens. W. E. Fischer (Ball's *Modern Ophthalmology,* p. 822) gives the following formula: Corrosive sublimate, saturated solution; alcohol (95-per-cent.) of each 100.0. The eyeball remains in the solution for twenty-four hours. It is then washed thoroughly in flowing water and finally is transferred to a brown-red solution of iodin in 70-per-cent. strength alcohol, which must be changed until it retains its brown-red tint. The iodin removes the sublimate crystals which were precipitated in the tissues. Sublimate is an admirable fixing agent for the preservation of karyomitotic figures.

Sublimatlösung. See **Aqua sublimatis, P. G.**, p. 546, Vol. I of this *Encyclopedia.*

Sublunate. Approaching the form of a crescent; subcrescentic.

Subluxation of the lens. See **Dislocation of the lens,**, p. 7202, Vol. X of this *Encyclopedia.*

Subluxation of the lens as a preliminary to its extraction in cataract operations is discussed under **Cataract, Intracapsular extraction of,** p. 1531, Vol. III of this *Encyclopedia,* and under the heading **Smith-Indian operation.**

As an appendix to these captions, Arnold Knapp (*Archives of Ophthalm.,* Jan., 1915; abstr. *Annals of Ophth.,* p. 323, Apr., 1915) reports that he has abandoned the Smith-Indian method, and now calls attention to the possibility of *subluxating the lens,* using Kalt's capsule forceps.

Corneal section should be just short of half of the corneal circumference with a conjunctival flap. An iridectomy is performed. The capsule is grasped not too tightly at a point below the center of the pupil. The closed branches of the forceps are gently moved from side to side, up and down, or rotated, and the capsule can be seen to follow in the various directions. The grasp should not be too tight, lest the capsule be torn. If dislocation of the lens is successful, the margin of the cataract appears in the pupillary space. The dislocated portion is

usually below, with the upper attachment unruptured. The forceps is then withdrawn and pressure is exerted straight back on the lower part of the cornea with Smith's hook, and the cataract can then be seen to "tumble." On delivery of the lens, it can be seen to be attached above and is finally separated by a lateral stroking motion. If the head presents first, delivery is slower and counter-pressure must be applied at the scleral margin.

Owing to the size of the whole lens, it sometimes becomes wedged in the iris angle and is often extracted with somewhat more trouble than in the ordinary operation. If the capsule ruptures during expression of the lens, it can usually be easily grasped and drawn out with the capsule forceps, after the contents have been expelled. Both eyes are bandaged for four days following the operation, unless there is an indication for examination at an earlier period.

The operation may be followed by some deep opacity at the cornea, especially if the lens be large and the incision small. This disappears at the end of a few days.

Knapp is apparently well satisfied with this operation, and presents statistics of one hundred cases.

Dislocation with the capsule forceps succeeds only in a certain percentage of cases, perhaps forty to fifty per cent. It should not be undertaken in unruly patients. It succeeds proportionately with the age of the cataract.

In the series of one hundred, prolapse of the vitreous occurred in sixteen cases; iritis or cyclitis in nine; prolapse of iris in six; detachment of the choroid in two; seventy-six cases were uncomplicated. The final results were excellent.

Nearly a year after Knapp began this operation, Stanculeanu reported on a method of extraction practically of the same nature, using the Manolescu forceps. Stanculeanu succeeded in dislocating the lens by this method in fifty to seventy per cent. of cases, and was well satisfied with his results.

Submarine telescope. A telescope used for observing submerged objects.

Subnormal. Abnormal by defect or deficiency.

Subocular. SUBOPTIC. Situated under the eye.

Suborbital. Situated beneath the orbit.

Subretinal. Lying beneath the retina.

Subretinal cysticercus. See p. 3661, Vol. V of this *Encyclopedia*.

F. Balbuena (*España Oftalmologica,* April, 1916; abs. *Ann. of Oph.,* Oct., 1916) reports a case. The parasite developed in the macular region, being seen as a bluish-white sac by artificial light, with trans-

lucent walls, traversed by the retinal vessels. Near to the center was seen a clear, rounded spot whose outlines were gradually lost in the rest of the cyst, and gave the sensation of something placed within or behind the sac. The history pointing to the presence of tapeworm, a teniafuge was given, with resulting expulsion of a worm. Immediate surgical intervention being refused, a subconjunctival injection of pelletierin was resorted to (one cubic centimeter of a one to five hundred solution). The following day the cyst showed a white spot in which there were oscillatory movements. Every few seconds this spot became more detailed, and the observer was able to see clearly the scolex with its four hooks. The vitreous became more cloudy, but the patient shortly disappeared. He returned eight months later, when the eye was enucleated after an unsuccessful attempt to extract the cysticercus through a scleral opening. The enucleated eye was demonstrated to contain the encysted cysticercus.

Substage. A stage situated beneath the ordinary stage of a compound microscope.

Substantia propria corneæ. The principal (third) layer of the cornea.

Substitution, Muscle. Under the title of "Muscle substitution" John B. Roberts (*Ophthal. Record,* August, 1916) describes his operation for *congenital ptosis.* The eyebrow is shaved and an incision carried from the root of the nose along the superciliary ridge almost to the external angle of the frontal bone. From the nasal extremity of this cut a vertical incision is made through the tissues of the forehead almost to the hair line. The flap is turned upward and outward so as to expose the occipito-frontalis muscle and tendon. Just beneath the upper orbital margin an incision down to the fascia of the upper lid is made from the nasal to the temporal side, following the curve of the bone. This skin flap is turned downward, the tarsal plate exposed and its upper edge identified. A tunnel is then cut beneath the soft tissues about half an inch in width extending under the orbicular muscle to the incision made through the shaved eyebrow.

From the muscular belly of the occipito-frontalis muscle immediately above the tunnel opening is cut a strip of fibers about a third of an inch wide and an inch and a quarter long. The parallel incisions making this strip diverge a little at their upper ends so as to make the muscular band wider near its upper extremity. A cross incision was made at the upper end converting the strip into a long flap.

This flap is turned downward, thrust through the tunnel and attached to and upon the upper edge of the tarsal plate by three silk sutures. The two corner sutures are put in as mattress stitches and hold the flap on top of, that is superficially to, the tarsal fibrous plate.

Returning to the frontal region Roberts cut on each side of the turned down flap two strips, each half the width of the inverted flap, having their only attachment to the muscle above. These were drawn toward the fold of the inverted flap, attached to it on its superficial surface, which formerly had been the under surface, by a mattress suture at each edge and were united in the middle line by a third suture, also put through the turned-over portion of flap so as to make a mattress suture. An additional suture was inserted at one edge where the first flap was bent over, to keep it thus folded. The superficial skin flap of the forehead was then replaced and sutured in position by silkworm-gut sutures. Subsequently the Berger operation, with arrow-head excision on each side, was performed for the epicanthus. The sutures were so placed as to lift a little the inner canthus of each eye. The wounds all healed by first intention. A satisfactory result in addition to the child's ability to raise the eyelid has been that the operation makes a normal furrow in the lid at the seat of the upper edge of the tarsal plate. This is conspicuously absent in severe cases of congenital ptosis. The result to date of report is excellent, though the time since operation has only been about two and one-half months.

Subtranslucent. Imperfectly translucent.

Subversion. A turning downward. See **Muscles Ocular.**

Subvolution. SUBINVOLUTION. The name given by Galezowski to an operation for pterygium. See p. 10462, Vol. XIV of this *Encyclopedia.*

Succedaneum. A drug or other remedy that may be substituted for another of like quality or properties.

Successive contrast. That form of contrast of colors in which, when one or more colors have been looked at for a length of time, the retina preserves for the time being the impression of the complementary color or colors. See p. 3276, Vol. V of this *Encyclopedia.*

Succinyl peroxide. See **Alphozone,** p. 275, Vol. I of this *Encyclopedia.*

Succory. In ancient Greco-Roman times, regarded as an ophthalmic remedy. See **Hawkweed,** p. 5706, Vol. VIII of this *Encyclopedia.*

Succussion. Forcible shaking with sudden arrest of the downward motion (on a pad or the knee), used in making homeopathic dilutions or potencies. At least ten such shakes should be given to each dilution. See **Homeopathy in ophthalmology.**—(J. L. M.)

Succus thebaicus. A name for opium, p. 9042, Vol. XII of this *Encyclopedia.*

Sucrose. See **Sugar.**

Suction curette. A name for the suction tube or aspirator used in the extraction of soft cataract. See p. 1555, Vol. III of this *Encyclopedia.*

Suction operation for cataract. This subject has been fully discussed under several headings elsewhere. See, e. g., p. 1554, Vol. III, and under **Aspiration of cataract**, p. 641, Vol. I, of this *Encyclopedia.*

Suda, Tatsuzo. An early Japanese ophthalmologist. Born in 1848 (I. year of Kasi) in Shinano Province, Japan, he studied English at the inauguration of the medical college of Tokyo, and afterwards, when the German professors Müller and Hoffmann came to Japan, he studied European medicine for the first time. He graduated at the Tokyo Imperial University in 1873, and in 1880 was made assistant professor at the same institution. In 1886 he began to engage in private practice.

A Japanese physician, who does not give his name, sent the writer the following personal description of Dr. Suda: "He usually spoke little and was exceptionally studious. He was gentle in his appearance, wore a long beard and taught his students with a fatherly kindness, while his attitude toward his patients was as tender as it could be, and he was in the consultation room from morn till night. One summer day, when he asked if the azaleas were blooming, his gardener answered, with a laugh, that they were in full bloom a few months before. This shows how devoted Dr. Suda was to his studies."

"As a good Buddhist, he attended the sick with care and pity," writes Dr. Komoto to the present writer, and adds that Dr. Suda is said to have seen and treated no fewer than 400 patients daily, many of whom gathered about his door before daylight. Suda died of lung disease in 1891, and was then succeeded in practice by his adopted son, the widely known Takuji Suda.—(T. H. S.)

Sudamina. These are small, pinpoint- to pinhead-sized vesicles, usually occurring on the hands; rarely observed upon the eyelids. They are caused by a too rapid formation of sweat, and are observed in summer. The application twice a day of a 1-per-cent. solution of chromic acid will bring about a cure.—(J. M. B.)

Sue, Jean Joseph. He was also called "Sue le Jeune" and "Sue de la Charité"; a well known Parisian surgeon and anatomist, who devoted considerable attention to ophthalmology. Born at La Colle, France, Apr. 20, 1710, a younger brother of the celebrated Parisian surgeon, Jean Sue, he became in Paris a Master of Surgery in 1751, his dissertation being "De Cataracta." For nearly forty years he taught anatomy in Paris. He died Dec. 15, 1792.—(T. H. S.)

Suffocation, Ocular indications of. See the middle third of **Ophthalmology, Legal relations of.**

Suffusio. (L.) An old term for cataract.

Suffusio colorans. Chromatopsia.

Suffusio dimidians. Hemiopia.

Suffusio exclarans. Buphthalmos.

Suffusio lentis. Cataract.

Suffusio multiplicans. Diplopia and polyopia.

Suffusio myodes. (L.) (Obs.) Metamorphopsia.

Suffusio nigra. An ancient term for amblyopia.

Suffusio oculorum. An old term for an opacity in the eye, especially in the crystalline lens.

Sugar. CANE SUGAR. SUCROSE. SACCHAROSE. LACTOSE. GLUCOSE. Cane or beet sugar (sucrose) is generally found as pure-white, dry, hard crystals soluble in about half of their weight of water; formerly dried in the form of a "loaf."

Mention has already been made of a mixture of this agent with calomel (q. v.), mercuric oxide and other substances as a dusting powder for the after-treatment of trachoma granulations. The Editor has also used fine powdered sugar alone for the same purpose, and is aware that it has been used by others but in all instances with no particular results. Its application is sometimes followed by pain, lachrymation and irritative injection of the bulbar vessels. Fuchs advises the use of simple syrups in the treatment of lime burns.

As an astringent excipient L. D. Brose finds the following finely powdered mixture, dusted into the eyes morning and afternoon, followed by massage, to be useful in chronic trachoma. The sugar has a distinct therapeutic value in the formula: Pulv. sacchar, alb., 10.00: Pulv. cupri citratis, 1.00.

Gosselin also advises the application of syrup (sugar solution) for the relief of lime burns, but this practice is condemned by Parsons (*Pathology of the Eye*, p. 1131, 1908) and others.

In the opinion of Murphy (*Year-Book*, p. 100, 1916) loaf sugar has several advantages over other mechanical means of destroying the trachoma granules. First the moisture of the eye sufficiently softens the sugar so that it is an ideal rasp to lacerate the granules, and secondly, the sugar lump acts as a sponge and takes up the blood leaving the field of operation practically bloodless, which is important in order that none of the granules be overlooked.

Lactose, milk sugar, also crystalline, is soluble in water and is employed mainly as an excipient or vehicle for medicines.

Glucose, corn or grape sugar. See p. 5592, Vol. VII of this *Encyclopedia.*

Sugar-loaf cornea. Conical cornea.

Sugar of lead. See **Lead acetate,** p. 7027, Vol. IX of this *Encyclopedia.*

Suggestion in eye diseases. See **Hypnotism,** p. 6112, Vol. VIII; p. 10441, Vol. XIV, and p. 7771, Vol. X, as well as **Hysteria,** in this *Encyclopedia.*

Suggillation. Black eye; ecchymosis of the lids. See p. 1006, Vol. II of this *Encyclopedia*.

Sulcus orbito-palpebralis. Furrow on the upper lid, due to contraction of a slip of the levator palpebræ superioris.

Sulcus scleræ. The groove at the sclero-corneal junction.

Sulcus subtarsalis. A slight depression near the posterior free border of the lid.

Sulphoid. Colloidal sulphur: used in alopecia.

Sulphur. This well known remedy is a polymorphic substance and is found in a number of pharmacal forms; as yellow transparent crystals; yellow, solid, cylinders (brimstone); precipitated sulphur (lac sulphuris), milk of sulphur; as a fine, amorphous, pale-yellow powder; sublimed ("flowers" of) sulphur, fine, yellow powder with a faint odor, and washed sulphur, a fine, yellow, dry, tasteless, odorless powder.

The therapeutic activity of this agent is mostly confined to prescriptions for scabies palpebrarum and such skin diseases as acne of the lids. A useful ointment is: Sulphuris pulv., gm. 1.0 (gr. xv); camphoræ, ol. olivæ āā, gm. 0.6 (gr. ix); ungt. simplicis, gm. 15.0 (℥ss).

Königstein uses a sulphur ointment with ammonium chloride to lids affected by styes. "Milk of sulphur" is present in Kummerfeld's lotion to the extent of 10 per cent.

In chronic ulcerative blepharitis L. D. Brose prefers the application of the following ointment. Before applying it the crusts are removed from the lid edges at night with tar soap: Pulv. sulphur, precip., ol. candini, pulv. zinci oxidi, āā 1.00; ol. olivæ, 2.00; lanolin, 9.00.

Darier (*Oph. Year-Book*, p. 35, 1916) writes on the use in syphilitic conditions of intramine, or diortho-amino-thio-benzene, a synthetic compound of sulphur, appearing as an amorphous, yellowish powder, which is not toxic in any dose. The usual dose for adults is one grain of the powder in 9 c.c. of olive oil or paraffin, the mixture being injected intramuscularly.

Colloidal sulphur in ocular inflammations. Bichon (*La Clinique Ophthalm.*, July, 1917, abstr. *Am. J. of Oph.*, Aug., 1918) believes that arthritis combined with syphilis is one of the most frequent causes of inflammatory processes of the iris and sclera affecting often both eyes. It may come during or following the acute joint condition. Up to the present the salicylates and aspirin have been used. but these drugs disturb the digestion and are too frequently followed by recurrences. Loeper obtained excellent results in rheumatic affections with colloidal sulphur. The method of choice is intravenous but it may be administered intramuscularly. Each ampule contains 2 cc. and is

given every day or every second day. A series is ten to twelve injections. Five observations from the army are published in detail. In none of the cases had pain or any other symptoms followed the injections. A complete cure was effected in every case in a much shorter period than necessary by the old time means.

Sulphuric acid. This well known agent has but few local uses in ophthalmology. Among these is its laboratory employment and its application as a cauterant. Of the latter, Quadria and Helling used it for producing a linear scar and consequent contraction of the lid skin in spastic entropion (q. v.).

Sulzer, Dr. A celebrated Parisian ophthalmologist, one of the editors of the *"Annales d'Oculistique."* Born at Winterthur, Switzerland, in 1858, he studied at Zurich, Strassburg, and Utrecht. Settling at first in the Island of Java, he removed in 1889 to Paris, thence to Geneva, and, eventually, to Paris again. In 1914, though 56 years of age, he entered the army of the allies as ophthalmic surgeon, and labored in that capacity until an ever-increasing cardiac difficulty compelled his return to Paris. The writer desires to acknowledge Dr. Sulzer's very great and ungrudging assistance in the gathering of biographic data about deceased French and Swiss ophthalmologists and also about various French ophthalmic laws and judicial decisions. Dr. Sulzer's list of writings is a long one. Perhaps his most important contributions were the following, all in the *"Encyclopédie Française d'Ophtalmologie:"* "Détermination de la Tension de l'Oeil. Ophtalmotonométrie" (II, p. 60); "Ophtalmométrie" (III, 59); "Les Ametropies Focales" (III, 287); "La Presbyopie" (III, 1127). He died Feb. 9, 1918, from angina pectoris.—(T. H. S.)

Sumac, Poison. See **Rhus toxicodendron**; as well as **Rhus vernix.**

Sun. The star which warms, governs, and illuminates the earth and the other bodies forming the solar system.

The investigation of the physical structure and chemical constitution of the sun has been in modern times most successful. In 1837 Pouillet measured the amount of solar radiation. Computations of the sun's temperature in degrees Cent. have varied from a few hundreds to many millions. We know with certainty that the most refractory substances are vaporized long before the solar temperature is reached. Of the sun's surface we have learned much. Iron, nickel, titanium, manganese, chromium, cobalt, carbon, vanadium, zirconium cerium, calcium, scandium, neodymium, lanthanum, yttrium, niobium, molybdenum, palladium, magnesium, sodium, silicon, strontium, barium, aluminum, cadmium, rhodium, erbium, zinc, copper, silver, glucinum, germanium, tin, lead, potassium, oxygen, hydrogen, helium, and *pos-*

sibly iridium, osmium, platinum, ruthenium, tantalum, thorium, tungsten, uranium, occur in the sun.

These as vapors form a layer upon the solar surface, which is in fact the solar atmosphere. Immediately beneath this is the photosphere, which marks to the eye the boundary of the sun's disc. Above this layer of vapors rise vast jets and clouds called variously *flames, prominences* or *protuberances*. Above these again is the bright and curiously shaped solar *corona*, extending along the ecliptic, as once seen, to a distance of twelve solar diameters.

The *photosphere* presents to the telescope of low power an apparently even surface. Under higher powers its structure is seen to be complex. The whole surface is granulated, resembling a gravel heap seen from a little distance. These granules have been described as like "willow-leaves" and "rice-grains." A multitude of minute dark points or pores, black in comparison with the granules, serve to emphasize their outline.

In certain regions of the photosphere, between 6° and 35° solar latitude, both N. and S. of the solar equator, large black spots are frequently observed. In size these vary from 150,000 m. in largest diameter to small black dots approaching in appearance the "pores." The activity of their producing cause is subject to a considerable variation, reaching a maximum every 11.11 years. There is an undoubted connection between this period and that of terrestrial magnetic phenomena. The spot is most probably a cavity formed in the photosphere by the pressure of a vast descending mass of vapor. In spot latitudes, for some unknown reason, these masses collect in unusual size, not descending by the minute "pores," but requiring large openings. White ridges (called *faculæ*) are raised in the neighborhood of spots, indicating enormous pressures, and spreading often over a wide area of the solar surface. The spectra of sunspots are most complex.

During total solar eclipses certain solar phenomena become visible, which bear closely on the problem of the sun's physical condition. Chief among these are the *corona, prominences*, and *chromosphere*. The last (sometimes called the *sierra*) surrounds the sun completely. It consists of a layer of vapors covering the entire photosphere. It is sometimes called the *reversing layer*, as by its absorptive action Fraunhofer lines are produced. As seen in eclipses it is of a beautiful rosy hue, and its surface, seen in profile at the edge of the solar disc, appears sharply jagged and broken into waves or spear-like jets of varied altitude. The chromosphere rises often in local jets of rosy gas to an enormous altitude. These form the *prominences*, first recorded as seen at an eclipse by Captain Stannyan, May 12, 1706. Since recorded at

many eclipses, they are now daily studied through the open slit of the spectroscope, a method devised by Lockyer and Janssen in 1868, and improved in 1869 by Zollner and Huggins. The corona, which varies in shape with the sunspot period, as yet can only be studied during the short period of a total eclipse, and its true nature has not so far been determined.—(*Standard Encyclopedia.*)

Sun-blinding. See **Eclipse amblyopia,** p. 4127, Vol. VI of this *Encyclopedia.* See, also **Blindness, Snow** and the captions **Glaring,** and **Dazzling.**

Sun-blindness. A term sometimes used for *functional day-blindness.* See p. 3777, Vol. V of this *Encyclopedia.*

Sunbow. An iris produced by the refraction of sunlight in any rising spray of vapor.

Sunburn. Dermatitis with burning and redness, due to exposure to the rays of the sun. See **Blindness, Snow.**

Sunburst, Astigmic. See p. 2010, Vol. III of this *Encyclopedia.*

Sun-glow. A diffused solar corona due to fine atmospheric particles.

Sunlight, Tropical. See p. 7476, Vol. X; as well as under **Ethnology,** p. 4527, Vol. VI, and under **Race,** p. 10835, Vol. XIV of this *Encyclopedia.*

Sun-picture. A photograph.

Sun-proof. Impervious to the sun's light.

Sunrise test. The half clock-face chart used for the determination of the meridians of astigmia. See p. 4647, Vol. VI of this *Encyclopedia.*

Sunshade. (a) A colored glass screen used in solar observations. (b) A tube projecting beyond the objective of a telescope to cut off oblique light.

Sunshine recorder. An instrument for indicating the duration of sunshine; usually either a spherical lens whose focus moves with the sun, and leaves a scorched path on a curved strip of paper, or a dark chamber in which the rays, admitted through a minute hole, trace a line photographically on sensitized paper. The instrument, adjusted by a thumb-screw to suit the angle of the sun, is so placed that the plates are exposed to the forenoon and afternoon sun respectively. When the sunshine penetrates the hole it makes a permanent track on the photographic paper inside the cylinder. Each day of the month the plates are shifted one notch downward, and the result is the printing of a complete record of the times and duration of sunshine for the month.—(*Standard Encyclopedia.*)

Sun-southing. The transit of the centre of the sun over the meridian at apparent noon.

Sunstroke. A very fatal affection of the nervous system, which is common in India and other tropical countries. Two contrasted forms are recognized. In the *cardiac* the heart is chiefly affected, and the symptoms are weakness, faintness, dimness of sight, giddiness, etc. In the *cerebro-spinal* form, the commoner of the two, the symptoms usually come on more gradually. The most striking feature of the disease is either wild delirium or coma, with a pungently hot skin and extremely high temperature—106° F. or upwards.

Treatment. Cold douches, perfect rest, exclusion of light, and, if required, free stimulation, are of most service.—(*Standard Encyclopedia.*)

Sun-wake. The rays of the setting sun reflected on water.

Sunwise. In the direction of the sun's apparent motion.

Superciliaris. Corrugator supercilii.

Superciliary. Pertaining to the region of the eyebrow.

Superciliary ridge. SUPRAORBITAL RIDGE. The prominence of the frontal bone just above the supraorbital arch. See **Anatomy of the eye.**

Supercilium. Plural, *Supercilia.* The eyebrow; an arched eminence of integument which surmounts the upper border of the orbit and supports numerous short, thick hairs, directed obliquely to the surface. It consists of thickened integument connected beneath with the orbicularis palpebrarum, corrugator supercilii, and occipito-frontalis. See p. 1040, Vol. II and under **Anatomy of the eye,** in this *Encyclopedia.*

Superduction. The act of drawing or rotating upward. See **Muscles, Ocular.**

Superficial punctate keratitis. See p. 6814, Vol. IX of this *Encyclopedia.*

Superficial scleritis. See **Scleritis.**

Superior cervical ganglion. See p. 4843, Vol. VI of this *Encyclopedia.*

Superior oblique muscle. See **Muscles, Ocular,** as well as p. 363, Vol. I of this *Encyclopedia.*

Superior polioencephalitis. See **Encephalitis,** p. 4305, Vol. VI and p. 10304, Vol. XIII of this *Encyclopedia.*

Superior rectus muscle. See **Muscles, Ocular,** and p. 359, Vol. I of this *Encyclopedia.*

Supernumerary caruncle. Parsons (*Pathology of the Eye,* p. 29) is doubtful of the occurrence of such an anomaly, and thinks the reported instances are probably examples of solid dermoid tumors.

Supernumerary eyelid. J. F. Shoemaker (*Am. Journ. of Ophthalm.,* August, 1914; review by Ernest Thomson in *Ophthalmoscope,* p. 35,

Jan., 1916) reports an instance of this extremely rare anomaly. A growth of irregular outline was situated at the inner canthus in the region of the caruncle, protruding between the lids about 5 mm. It was attached in the region of the caruncle to the lower lid by a narrow band almost at its junction with the upper lid. The punctum and canaliculus were not involved. The growth was removed. The lower lid had a very small notch in its edge, to the temporal side of which the growth was attached. Shoemaker has been unable to decide whether this notch represented a coloboma on the lid or had been caused by pressure of the growth.

The anatomical examination was made by Alt, who said that, "Microscopically the growth is made up of all the elements found in the caruncle and lid, but particularly in the latter, arranged in an abnormal manner. . . . It appears as if the supernumerary lid was grown out from the caruncle. The lid portion, which is 6 mm. long, is covered with cutis and bristles with fine and coarse, partly pigmented, eyelashes, which grow in all directions. Between them are numerous small sebaceous and modified sweat glands, held together by dense connective tissue. Farther back there are a number of atypical glandular structures which, however, easily recall the arrangement of Meibomian glands, although neither the glandular acini nor the apparent excretory ducts have a continuous lumen. They are mostly solid epithelial structures which show a lumen only here and there. There are also a number of bundles of muscular fibres in this part irregularly distributed among the other structures. Just where the lid portion and the caruncular portion join each other there is an opening into the depth of the tissue, which from the character, arrangement and thickness of its epithelial lining, is easily recognized as a lachrymal canaliculus. Following this up in the different sections it is found to end in a blind sac lined with the same epithelium in the depth of the tissue of the lid."

The caruncular portion shows all the elements of the normal caruncle, hair, sebaceous glands and a sweat gland embedded in dense connective tissue, but not arranged in the normal manner. A most peculiar cone of epithelial cells, with its base on the surface, reaches for quite a distance into the depth. The cells of this cone look very much like the cells of a Meibomian gland; there are, however, no glandular acini, neither is there a lumen. Near the base of the growth, where it was cut off, there is in some sections a second such epithelial cone.

Alt could find no mention of a similar anomaly.

Supernumerary puncta. See p. 2942, Vol. IV of this *Encyclopedia*.

Superstitions of ophthalmology. See **Popular ophthalmology,** p. 10313, Vol. XIII; **Ophthalmology, History of; Evil eye,** p. 4554, Vol. VI; **Ophthalmophobia,** p. 8934, Vol. XII, and similar captions in this *Encyclopedia.*

Supertraction crescent. In contrast to "distraction" crescent. In high myopia, as pointed out by Jaeger, the retina is dragged over (supertracted) to the nasal side of the optic disk by the increase in size of the eyeball; forming in some instances, also a crescentic shadow, concentric to the papilla and marking the border of the posterior staphyloma (q. v.).

Superversio. See **Muscles, Ocular.**

Support. (F.) Holder.

Suppressio mensium. Suppression of the menses. See **Climacteric,** p. 2291, Vol. III, as well as pp. 7644 and 7645, Vol. X of this *Encyclopedia.* Sudden suppression of the menstrual flow has been held responsible for many eye affections. Among these are *neuritis* and *optic atrophy* (Mooren, McKay), *retinal hemorrhage* (Courserrant), *iritis* (Teillais), *ulcer of the cornea* (Daguenet) and *vitreous hemorrhage.* Just how these results are brought about it is not easy to imagine. Leber attributes them to an intraocular hyperemia; Berger and Loewy prefer the general toxemia theory.

Suppression of the image. See p. 6175, Vol. VIII, p. 290, Vol. I and **Learning of vision,** p. 7028, Vol. IX of this *Encyclopedia.*

Suppurare. (It.) To discharge, like an abscess. To suppurate.

Suppurative choroiditis. See p. 2144, Vol. III of this *Encyclopedia.*

Suppurative conjunctivitis. Purulent conjunctivitis. See p. 3135, Vol. V of this *Encyclopedia.*

Suppurative dacryocystitis. See p. 3723, Vol. V of this *Encyclopedia.*

Suppurative iridochoroiditis. Purulent iridochoroiditis; panophthalmitis. See p. 9230, Vol. XII of this *Encyclopedia.*

Suppurative iritis. Purulent iritis. See p. 6668, Vol. IX of this *Encyclopedia.*

Suppurative keratitis. See **Cornea, Serpent ulcer of the,** p. 3447, Vol. V of this *Encyclopedia.*

Supracapsulin. A trade name for epinephrin (q. v.).

Suprachoroidea. ECTOCHOROIDEA. The outermost layer of the choroid coat; the loose tissue between the sclerotic and the choroid coat of the eye; called also the *suprachoroid lamina.*

Suprachoroiditis. See p. 2149, Vol. III of this *Encyclopedia.*

Suprachoroid lamina. See **Suprachoroidea.**

Supraciliary. SUPERCILIARY. Situated above the eye; relating to the region of the eyebrow.

Supradin. A patented dry preparation of the suprarenal capsules, containing 0.015 per cent. of iodin. It is used in diabetes insipidus, neurasthenia, melasma, and vasomotor disturbances.

Supranephran. One of the numerous organic preparations derived from the suprarenal glands; employed in a solution of 1:1000. The remedy has a marked effect in elevating the blood-pressure and in all respects resembles adrenalin and similar agents.

Supra-obliquus. Superior oblique muscle.

Supra-ocular. Above the eyeball.

Supraorbital. SUPRAORBITAR. Situated above the orbit.

Supra-orbital bands. The thickenings above and to the outer side of the eyes in the embryo.

Supra-orbital canal. The canal at the upper margin of the orbit, transmitting the supra-orbital artery and nerve.

Supra-orbital foramen. A notch in the superior orbital margin, at the junction of the middle with the inner third, sometimes converted into a foramen by a bony process, or a ligamentous band. It is the orifice of a groove in the upper wall of the orbit, which transmits the supra-orbital artery, veins, and nerve.

Suprarenaden. This is the trade name of a preparation of the suprarenal capsule (q. v.) marketed by Knoll & Co. It has the same action as similar extracts of the adrenal glands and has been tested and recommended by a number of observers.

Suprarenal capsule and its derivatives. See **Adrenalin, Suprarenalin, Adrin, Suprarenin, Atrabilin, Epinephrin.** This hemostatic extract of the suprarenal capsule or gland is marketed by Merck as light, brownish particles that make a turbid solution with an equal weight of water. The solution should be freshly prepared, each time it is used, with sterile, distilled water in which case its vaso-constrictor and styptic properties are well developed. Although this method of obtaining the local effects of the adrenal bodies may not be as cleanly as the use of adrenalin (q. v.) and similar preparations, in the Editor's experience the blanching of the lid skin is more marked with the extract.

Rosenhauch and Matusewicz report from their experimental study that instillations or subconjunctival injections of weak solutions of adrenal preparations, continued for months, leave no permanent anatomical changes in the conjunctiva. The adrenal preparations do not increase the action of atropin in man, but they do increase the action of pilocarpin in rabbits. Ciliary injection in the human eye is not diminished by them. They are contraindicated in atonic ulcer of the cornea, and are not appropriate for acute iritis and iridocyclitis.

Often the instillation in one eye causes conjunctival anemia in the other.

Hull points out the value of adrenalin as a diagnostic agent. A weak solution dropped in the conjunctiva, by removing the more superficial hyperemia, brings out the pericorneal zone of iritis, or the deeper redness of scleritis or episcleritis. It also removes the swelling which may hide trachoma granules.

Suprarenals—In from five to ten seconds after the intravenous injection of epinephrin in rabbits and cats, the pupil begins to dilate, the nictitating membrane to retract, and slight ptosis to occur. These phenomena reach their height in from five to twenty seconds, and last about two and a half minutes longer. In dogs, after medium doses, there is miosis, enophthalmos and adduction of the eye, probably through oculomotor stimulation from increased intracranial tension. Toxic doses, however, produce dilatation of the pupil. In man, in the presence of paralysis of the sympathetic, the conjunctival instillation of epinephrin produces mydriasis. From observation of the constant use of epinephrin in daily practice for a number of years Santos-Fernandez finds that it only infrequently produces mydriasis. According to Nieden, the local use of epinephrin diminishes lachrymal secretion, and we are all familiar with the contraction of the vessels which results.

When a 1 per cent. solution of epinephrin is instilled into the conjunctival sac of animals deprived of the thymus gland, epithelial bodies or thyroid gland, the pupil becomes dilated in all, but with this difference: that where the thymus has been extirpated, it occurs only after the lapse of weeks, whereas after extirpation of the thyroid it occurs within a few hours. In the presence of pancreatic lesions, repeated instillations produce dilatation of the pupil. In exophthalmic goiter and during the administration of thyroid extract dilatation of the pupil may occur when epinephrin is instilled into the eye. This is due probably to the increased irritability of the sympathetic.

According to Bayer, the contradictory observations on the effects of epinephrin on intra-ocular tension have been brought to agreement by the studies of Ruberts which have shown that when epinephrin of the usually applied strength is instilled into the normal eye it causes no fluctuation of the tension, while in the glaucomatous eye this is very marked. First there is a diminution, then an increase, and finally a decrease. In glaucomatous eyes it must therefore be used with caution.

Suprarenalin. This is a suprarenal capsule derivative that closely resembles adrenalin chloride. It is marketed in 1 to 1000 watery solu-

tion. It relieves the ordinary congestion of the vessels supplied to the anterior globar section and to the palpebral conjunctiva, "whitens" the sclera and is one of the most effective agents for giving a clear field in strabismus and other bloody operations on the eyeball.

H. V. Würdemann uses the following collyrium for simple conjunctivitis and hyperemia of the lids: Suprarenalin (1-1000), 3.00; sodii boratis, 0.50; chloreton, 0.06; sol. sodii chloridi (75 per cent.) ad., 30.00.

Suprarenin. Hydrochlorid of dioxyphenylethanolethylamin (ethyl amino-alcohol), a substance derived from the suprarenal gland, and said to be its active principle. It occurs as a gray-white, crystalline powder, very slightly soluble in water. It has the qualities and clinical properties of adrenalin and suprarenalin and is employed in the eye in the same doses. It may be said to be the much-exploited German equivalent of our adrenalin chloride (q. v.) It is used in ocular therapy in solutions of 1:10,000 to 1,000. Like other suprarenal derivatives it should not be exposed to light. The suprareninum hydrochloricum of the Höchster Farbwerke is a sterile 1:1,000 solution without a preservative, dissolved in normal salt solution. It is said to be miscible with cocain, eserin, atropin or zinc sulphate, without producing decomposition. See **Suprarenin borate** and **Suprarenin, Synthetic.**

Suprarenin borate. This salt forms white crystals, of which 1.3 grm. contains a gramme of pure suprarenin. It is very soluble in water and for that reason is often to be preferred to suprarenin which dissolves with difficulty. It has all the vasoconstrictor and hemostatic qualities of the suprarenal glands and is generally employed in conjunction with local anesthetics in eye surgery. It is also marketed in a sterile solution corresponding to the 1:1000 standard solution of suprarenin (q. v.).

Suprarenin, Synthetic. Methylaminoalcohol. According to the reports of the proprietors (Farbwerke Hoechst-am-Rhein) the action of suprarenin synthetic is a little more pronounced than that of suprarenin obtained from suprarenal bodies, said to be due to its absolute chemical purity. It causes a rise in blood pressure, vascular constriction, dilatation of the pupil, and diuresis with elimination of sugar identical with that from the natural product.

It is a nearly white, fine granular, inodorous, crystalline powder, almost insoluble in water, alcohol and ether, and fuses at 207-208° C. The chemical and pharmacodynamic examinations of this preparation prove it to be (according to the owners) identical with the suprarenin prepared from the suprarenal gland. Its action as a vasoconstrictor,

blood-pressure raising and pupil dilatant is identical with suprarenin prepared from the animal gland. Comparative experiments between the synthetic and the natural suprarenins demonstrated them to be identical in their toxic properties. The tests of identity of the synthetic product are identical with those of suprarenin from the natural gland. However, with oxalic acid, the synthetic base forms a well-defined crystalline salt which is stable in the air.

With hydrochloric acid, the base forms a well-defined crystalline salt, stable and readily soluble in water.

Suprarenin synthetic hydrochlorid is marketed in glass tubes containing 0.06 grm. and 1.2 grm. each; as well as in sterile solutions 1 to 1,000 in 1-ounce bottles and in sealed ampules containing 1 c.cm.; in hypodermic tablets, tubes of 20 tablets 1/200 gr. each. In combination with the local anesthetic novocain it comes in tubes of 20 tablets No. 1 suprarenin synthetic hydrochlorid 1/200 gr., novocain 1/3 gr.; No. 2, suprarenin synthetic hydrochlorid 1/400, novocain 1/6 gr. It is used in conjunction with local anesthetics for local anesthesia, rendering the parts bloodless; it is also recommended *by the proprietors* as a sovereign remedy in episcleritis, spring catarrh, chronic conjunctivitis, iritis, glaucoma and in operations.

Kraupa (*Year-Book,* p. 49, 1909) reports that synthetic suprarenin shows the same action as the other adrenal preparations, and this is not impaired through sterilization by boiling.

Suprascleral. On the outer surface of the sclera.

Supratrochlear. Situated above the trochlea, or pulley of the superior oblique muscle.

Supratrochlear nerve stretching. See **Stretching, Nerve.**

Supravaginal space. That which surrounds the sheaths of the optic nerve.

Supravergence. See **Muscles, Ocular**; also **Prism verger,** p. 10383, Vol. XIII of this *Encyclopedia.*

Surface-curvature. See p. 7239, Vol. X, of this *Encyclopedia.*

Surface needling of the cornea. Seeley and de Beek have observed marked improvement in vision in eyes which had been tattooed and in which the pigment had disappeared. This observation led them to adopt the usual steps of tattooing, omitting the India ink. This surface-needling of the cornea is simply pricking the opaque tissue with the needle. The conjunctiva is washed with sterile water and the pricking is done with a sterile instrument. The operation may be repeated at intervals of about a year. In many cases vision will be increased from the counting of fingers at seven feet to V. = $^{20}/_{200}$ or even $^{20}/_{50}$.—(J. M. B.)

Surfaces, Refracting, in the eye. See **Physiological optics.**

Surgeon's knot. A square knot in which one end of the cord is passed a second time through the loop before the second knot is formed.

Surgery, Military. The surgery which deals especially with the injuries received in war. See p. 7706, Vol. X of this *Encyclopedia;* also **War, Ophthalmic medicine and surgery in.**

Surmenage. (F.) Over-strain; exhaustion from over-exertion.

Sursumduction. Sursumvergence. The act of elevation of the visual axis of one eye above the other; the ability to elevate the axis of one or of either eye above that of the other; the degree to which one eye can be carried above the other by voluntary effort; denoted as right or left sursumduction according as the right or left eye is made the higher. See **Muscles, Ocular.**

Sursumvergence. See **Sursumduction.**

Sursumvergent squint. See **Strabismus sursumvergens.**

Sursumversion. An act of turning or directing upward; used chiefly of a simultaneous and equal upward turning of both eyes.

Surveyor's transit. A form of theodolite, in which a compass needle is fixed at the centre of the graduated circle.

Suspensory ligament. The zonula of Zinn. See p. 5963, Vol. VIII of this *Encyclopedia.*

Susruta. One of the oldest of Indian (Hindu) physicians, author of the "*Ayur-Veda,*" or "Science of Life." This book (at least its contents) was, according to Hindu belief, originated by Brahma himself. By him it was given to Dhanvantari, the physician of the gods. This worthy, in turn, communicated the "*Ayur-Veda*" to Susruta, the subject of this sketch, who reduced the whole to writing. See **Hindu ophthalmology,** p. 5924, Vol. VIII of this *Encyclopedia.*—(T. H. S.)

Suture. (1.) A surgical stitch or seam. See **Sutures in ophthalmic surgery.** (2.) The line of juncture of adjacent bones. (3.) A particular form of operation or act in an operation, in which the stitch or suture plays an important or the chief role.

Suture, Absorbable. See **Sutures in ophthalmic surgery.**

Suture, Advancement. A. T. Ewing (*Am. Jour. Ophthalm.,* May, 1915, abs. *Annals of Ophthalm.,* p. 133, Jan., 1916), has added three sutures to the five which he formerly used in the advancement operation. He uses the sutures to close the conjunctival wound and to support the new attachment of the muscle, should the other sutures become loosened. The eight double-armed sutures are introduced after exposing the muscle, but before it is severed, sutures one, two and three are placed at the point of the tendinous insertion of the muscle, and

advancement sutures four, five and six are then placed through the muscle at some distance from the insertion, leaving the part of the muscle to be resected between them and the first three sutures. These sutures are passed from behind the muscle. The last two sutures are introduced well back in the muscle from the conjunctival surface, in such a way as to include the conjunctiva and the muscle. After grasping the muscle with the advancement forceps, it is divided near its tendinous insertion. The globe is then brought to slight overconnection by fixation forceps, and sutures one, two and three are passed through the muscle from behind at the proper position and out through the distal conjunctiva. Then the conjunctiva near the cornea is undermined and sutures four, five and six are passed under it so as to get a hold in the episcleral tissue. These are brought out through the conjunctiva, the upper one forty-five to sixty degrees above the horizontal meridian, the lower one the same distance below the horizontal meridian, and the middle one so as to include the horizontal meridian in the tie. The opposite muscle is then tenotomized and sutures four, five and six are tied, bringing the globe into the position desired. Sutures seven and eight are then passed through the tendinous insertion of the superior and inferior oblique muscles and tied. Sutures one, two and three are then tied and the wound of the conjunctiva at the site of the tenotomy of the opposite muscle is closed.

Suture, Béclard's. A modification of Bertrandi's suture in which the needle is threaded with both a black and a white thread, so that, when it is removed, the threads are pulled in opposite directions.

Suture, Bertrandi's. A continuous suture passed "through and through," as in basting.

Suture, Buried. Sutures that are completely covered by skin and do not involve that structure at all. For the relief of discomfort and

O'Connor's Buried Knot Suture. A, sutures placed; B, tied.

pain, mostly due to the knot in the suture, after operations that require conjunctival sutures, Roderic O'Connor (*Ophthal. Record*, March,

1916) conceived the idea of burying the knot and using an absorbable material such as triple 0 catgut or finely shredded kangaroo tendon.

The needle pierces one margin from underneath, crosses over and pierces the other margin from without. As the knot is tied the loose conjunctiva everts easily and when the ends are cut it returns to its normal position carrying the knot with it. The writer prefers kangaroo tendon as it can be made much finer than the finest catgut, and is softer. O'Connor has tried this suture in a number of cases of advancement and in one was able to allow the patient entirely to dispense with even a monocular bandage. She was a girl of 12 and was able to use her eyes without any pain whatever. The same result was obtained in another case of operation on a superior rectus, in which there is usually a great deal of pain from knot irritation.

Suture, Cobbler's. A form of suture in which a double-threaded needle is passed through both lips of a wound and one end of the thread is caught, pulled through the needle, and withdrawn; when the needle is passed back in taking a second stitch the remaining thread is removed from the needle and the thread left on the opposite side is inserted and the needle withdrawn.

Suture, Continued. CONTINUOUS SUTURE. The closure of a wound by means of one continuous thread, usually by transfixing first one lip and then the other, alternately, from within outward. See **Sutures in ophthalmic surgery.**

Suture, Corneal. See **Injuries of the eye,** as well as **Corneal suture in cataract extraction,** p. 3392, Vol. V of this *Encyclopedia.*

A corneal suture is described by Wiener (*Oph. Year-Book,* 1916). A gold strip 1 mm. wide and 5/1000 of a mm. in thickness, having holes 1 mm. apart, is placed on each lip of the wound. Double armed sutures are then passed as shown in the figures, first through the opening in one gold strip, and then through the adjoining flap of the wound, next through the other flap and finally through the holes in the other strip. These sutures are tied alternately, drawing on them more firmly until the edges of the wound are approximated. The stitch has been used experimentally to bring together the edges of the cornea after a large piece has been excised, and may be of especial value in keratoconus. (See cut on next following page.)

Suture, Dry. The application of adhesive plaster to each side of a wound and the subsequent stitching of the edges of the plasters together.

Suture empennée. SUTURE EMPLUMÉE. SUTURE ENCHEVILLÉE. (F.) Quilled suture.

Suture en surjet. (F.) That form of continuous suture in which the thread is carried back after the last insertion and tied to the other end, left long for the purpose.

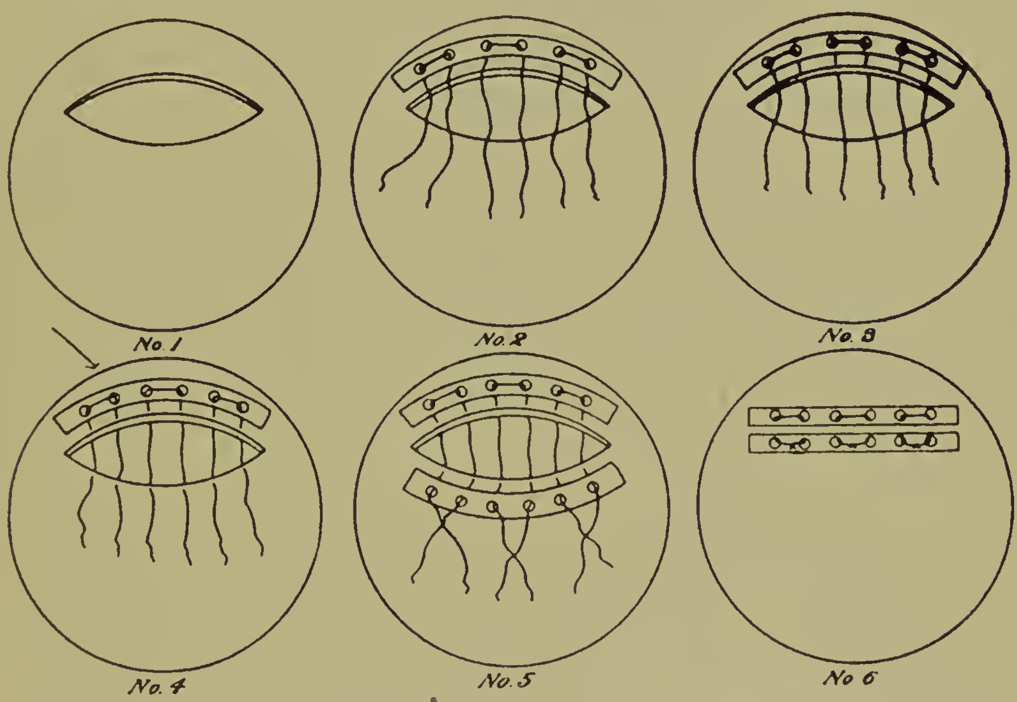
Suture entortillée. (F.) Twisted suture.

Suture entrecoupée. (F.) Interrupted suture.

Suture, Figure-of-eight. See **Suture, Twisted.**

Suture forceps. See **Forceps.**

Suture, Gaillard-Arlt. See p. 4335, Vol. VI of this *Encyclopedia.*



Wiener's Corneal Suture Plates. 1. Elliptical opening in cornea, to be closed. 2. Upper suture plate laid in proper position. 3. Sutures passed through upper margin of wound. 4. Sutures also passed through lower margin. 5. Lower plate in position, sutures drawn through ready to tie. 6. Wound closed by tying sutures.

Suture, Interrupted. A suture formed by single stitches inserted separately, the needle being usually passed through one lip from without inward, and through the other from within outward. See **Sutures in ophthalmic surgery.**

Suture, Lachrymoconchal. The line of junction of the lachrymal with the inferior turbinated bone.

Suture, Lachrymomaxillary. A suture (line of union) on the inner wall of the orbit between the lachrymal bone and the maxilla.

Suture, Mattress. See **Injuries of the eye.**

Suture, Metallic. See **Sutures in ophthalmic surgery** as well as p. 5258. Vol. VII of this *Encyclopedia.*

Suture needles. See **Needles for ophthalmic use**, p. 8291, Vol. XI of this *Encyclopedia.*

Suture, Ophthalmic. See, **Sutures in ophthalmic surgery.**

Suture perdue. (F.) Buried suture.

Suture, Pin. See **Suture, Twisted.**

Suture, Plastic. A form of suture devised by J. Pancoast, and so named by him, for use in his method of increasing the chances of union in superficial wounds by enlarging the extent of the surfaces approximated. A groove is formed along one lip of the wound, on its cut surface, and the other lip is beveled in such a manner that it will fit into the groove. The thread is passed from without inward through (1) the outer lip of the groove, (2) the beveled lip, (3) the deep lip of the groove; then, forming a loop on the deep surface of the grooved lip, it is passed through the same structures again, traversing them at a different place and in inverse order. The two free ends are then tied over a small roll of adhesive plaster laid on the cutaneous surface of the grooved lip.—*(Foster.)*

Suture plate. See **Sutures in ophthalmic surgery.**

Suture, Quilled. Quill suture. An interrupted suture in which a double thread is passed deep into the tissues, even quite below the bottom of the wound, the needle being so withdrawn as to leave a loop hanging from one lip and the two free ends of the thread from the other. A quill, or, more commonly, a piece of bougie is passed through the loops, which are tightened upon it, and the free ends of each separate thread are then tied together over a second quill, the object being to bring the deep parts into firm coaptation.—(*Foster.*)

Suture scissors. See **Stitch scissors.**

Suture sèche de Goyrand. (F.) A form of dry suture in which a strip of cloth saturated with collodion is placed on each side of the long axis of a wound, each strip having attached to it strings which, when tied together, approximate the edges of the wound.

Suture sèche de Mazier. A modification of the *suture sèche de Goyrand* in which the edges of the strips are stitched together.

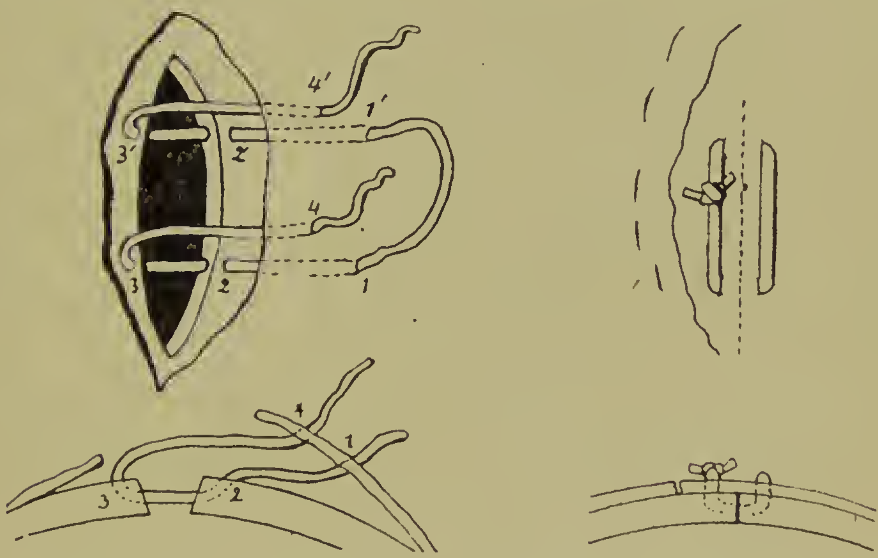
Suture, Shotted. A form of suture in which both ends of a wire are passed through a perforated shot that is then compressed tightly over them.

Suture, Subcuticular. A buried continuous catgut suture in which the needle is passed horizontally beneath the epidermis into the cutis vera, emerging at the angle of the wound, then in a similar manner passed through the cutis vera of the opposite side of the wound, and so on until the other angle of the wound is reached.

Suture, Relief. A row of supplementary sutures including the tis-

sues to the extent of 1 or 1½ inch on each side of a fistula or a deep wound, for the purpose of lessening the strain on the coaptation sutures. Also called *tension suture.*

Suture, Scleral. To prevent the infection of penetrating wounds of the eyeball Landolt (*Oph. Year-Book*, p. 42, 1916) has devised a suture that will close both conjunctival and scleral wounds, and at the same time draw the conjunctiva well over the scleral opening. The stitch is illustrated in the figures. A double-armed suture is used and each needle is passed as indicated by the successive numbers, 1, 2, 3, and 4, in the figures. The last one shows the effect when the stitch is tightened. The first introduction of the needle into the conjunctiva



Stitch for Closing both Conjunctival and Scleral Wound, and Covering the Latter (M. Landolt).

(1) is some 8 mm. from the edge of the wound; and the final emergence (4) at about half that distance.

Sutures in ophthalmic surgery. STITCHES. LIGATURES. This subject (of much importance to the ophthalmic surgeon) has been partially and incidentally covered under numerous headings (mostly of ophthalmic operations) in this work. See, for example, under **Blepharoplasty**; **Entropion**; **Muscles, Ocular,** and similar captions.

The Editor (Wood's *System of Ophthalmic Operations,* Vol. I, p. 239, and elsewhere) has pointed out that *silk, linen, cotton,* the so-called *"catgut,"* (see p. 1782, Vol. III) *kangaroo tendon, silkworm gut, horsehair, wire* (gold, silver, copper, iron) and other materials have been used in ophthalmic surgery.

Of the various kinds of sutures generally used, three common forms might be briefly mentioned here.

The *interrupted suture* is, as its name implies, composed of a series of single loops of suture material passed across the wound from side-to-side. The number and distance between these sutures is determined by what is found necessary to produce accurate apposition of the edges of the wound. In tying the units of this suture the ends are crossed to make a single or double knot, which is drawn down to the surface of the tissue by pulling on the two ends. Both ends are then drawn rather forcibly to one side, and the second knot tied. This maneuver places the knot just at the point of entrance of the suture into the skin, and not in the line of incision.

The *continuous suture,* is not so often employed, and consists in first passing a loop cross the line of incision. This may be tied or not. Subsequent loops are similarly passed, the suture being carried from one to the other without being cut to form single units. This suture is more difficult to remove than the interrupted suture, as no part of it can be removed or loosened without interfering with the whole.

Tension sutures are used for support, as in holding flaps in place after certain plastic operations. They are generally deeply-placed sutures of heavy material, introduced well back from the wound edges, in pairs, the adjoining ends on the same side of the wound being tied over a piece of gauze or glass bead to prevent their cutting into the tissues. In addition to these, one of the other forms of suture is used to secure apposition of the wound.

In *removing sutures* the thread should be grasped with the points of small, smooth-pointed forceps at one side of the knot and drawn out a little from its bed. It is then cut with scissors (see **Scissors, Suture**) as close to the point of its emergence from the tissue as possible, and then entirely removed. In this way one avoids drawing through the tissues any portion of the thread that has been exposed, and possibly contaminated, so that the risks of wound infection are materially lessened.

Silk, the suture-material most commonly used in ophthalmic surgery, may be converted into a most useful form of *waxed thread* after the method of Claud Worth (*On Squint,* p. 204). It is designed particularly for advancement operations and is prepared as follows: A reel of specially thick, black silk is wound loosely around a winder made by bending a piece of galvanized iron wire. It is boiled in water to sterilize it and to remove the superfluous coloring matter. It is then dried before a fire. The end of the silk is then threaded through a large glass bead. The bead is then dropped into a glass beaker containing a very hot mixture of white beeswax, three parts, and white vaseline five parts. The whole of the silk is drawn through the boiling

mixture, and is wound on a large glass reel. It is then kept in a sterilized glass jar, always ready for use without further preparation.

If possible, *suture materials should be black (iron-dyed)* or otherwise colored to facilitate easy recognition for removal. This latter is assisted in the case of conjunctival sutures, by the use of the suture plate devised by Geo. Price. It consists of a small silver plate, oval in shape, and about 9 x 5 mm. in size, with two holes in it, through which the ends of the suture are passed and the knot tied on the plate, which in turn lies smoothly on the ball. In certain muscle operations, where a bunching up of the tissues included in the suture is not desirable, the suture plate serves to hold them flat.

After operations involving incision in the skin in the region of the eye, accurate apposition of the edges of the wound should be secured, as early healing is thereby promoted and the subsequent scars are rendered much less conspicuous. In case the sutures are used to secure apposition only, and little if any tension is put on them, they should be removed in twenty-four hours, as they have by that time served their purpose and their further retention can only lead to irritation.

It should be remembered that the use of sutures is to secure apposition, while bandages give support. Sutures are foreign bodies, and should be dispensed with at the earliest possible moment. Where they are intrusted with the holding of parts in place that would otherwise tend to be displaced, as after blepharoplasty, pterygium operations and advancement of muscles, they must be left in position longer. Under these circumstances three days for the conjunctiva and six for muscle and skin will be found to be the proper time.

Gifford (*Trans. Sec. Ophthal., A. M. A.*, p. 146, 1903) believes that if skin sutures are touched daily with a 4 per cent. solution of nitrate of silver they can be left in place longer without exciting suppuration.

Surgical catgut, according to the following description given by the makers, Bauer and Black, Chicago, is prepared from the submucosa or second layer of the small intestine of the sheep. This portion of the ovine alimentary canal measures about eight yards and yields sufficient material on an average for five yards of medium size catgut. Thus for only one gross of one-hundred-foot medium ligatures about a thousand sheep are required. Animals from the western prairies seem to furnish a superior quality of raw material. Only those are used that have passed a rigid government inspection. The gut as removed from the animal is stripped, placed in iced antiseptic solution, thus immediately removing the animal heat, and promptly transferred to the machines used for its purification. The material is separated by a special device which insures strands of equal size and

even tension. After thus being cut into strips, the strands are subjected to three cleansing processes: First, scraping and washing by means of rapidly rotating knives, second, a series of thorough hand scrapings, and finally a washing and scraping by means of a machine designed for the purpose. Each strand goes through twenty-four distinct and thorough cleansings in water, with immersion in an antiseptic solution before each process. It is then twisted, dried under tension and finished under the strictest aseptic conditions. Finally, all ligatures are boiled in alcohol as a further purifying process, dried thoroughly, sterilized and tested bacteriologically. Bauer and Black also give the following history of the absorbable suture.

The absorbable suture, past and present. Surgeons have always felt the need of an absorbable suture and ligature material, and catgut when strong and sterile meets the requirements better than anything else.

In 1817 Sir Astley Cooper suggested that violin strings might be used in surgery; but infections following their use were so discouraging that little was accomplished until Sir Joseph Lister introduced antiseptic methods. Then catgut was treated with various antiseptics and germicides, such as carbolic acid and corrosive sublimate, with the idea not only of sterilizing but making it antiseptic. The results were not entirely satisfactory, chemical sterilization not only being sometimes inefficient but the product often causing irritation or interference with the healing processes. Thus until comparatively recent years a cloud of doubt and uncertainty has hung over catgut which strongly militated against its use. Spencer and Gask, in their *Practice of Surgery*, p. 176, 1910, say that catgut is prepared by "allowing sheep's intestines to rot, then twisting up the remainder, consisting mainly of the submucous coats and fibrous tissue. In this way many virulent germs are included which have then to be destroyed." Nothing could be more diametrically opposite the aseptic methods now used in preparing catgut. With clean handling from the start and improved methods of sterilization within germ-proof wrappers and hermetically-sealed glass tubes, all requirements of the most critical operator have been met.

Chemically speaking, catgut is a colagen, or gelatin product. When boiled in water catgut is so largely converted into gelatin as to lose its strength. Heating catgut above 212° F., unless all moisture has been driven off below that temperature, has much the same effect. So sterilization of catgut in boiling water or steam is entirely impractical. Dry sterilization, under conditions insuring conservation of strength, naturally results in a ligature which is not as flexible as many operators

desire. All that is necessary, however, to secure any degree of flexibility, is to drop the catgut into sterile or antiseptic water for about a minute immediately before using, removing from the water when the desired pliability is attained. The positive safety secured by resterilization after hermetically sealing more than outweighs the very slight trouble of dropping the catgut into sterile water. If catgut is put up with sufficient moisture to make it very flexible it cannot be sterilized after sealing without spoiling it. Even boiling the tubes in water is usually sufficient to ruin catgut which has been put up with a full degree of flexibility, the result conclusively proving that such ligatures could never have been sterilized after sealing.

A perfectly dry string which is very strong when given a hard steady pull sometimes may break with a sharp pull on a knot, where if given an opportunity to take up a little moisture there would be no trouble. It is simple enough to put up a sterilized gut in tubes which will be very flexible when the tube is broken; but as this is done by allowing the ligature to take up some moisture it is impractical to resterilize in the autoclave after sealing.

The strength of catgut is gauged by a dynamometer, an accurate spring balance with a sliding indicator that remains in position on the scale when the ligature breaks under pulling strain. The string to be tested is thrown over a smooth grooved wheel attached to the lower portion of the sliding shaft and the weight indicated divided by two to reduce the breaking strain of the double to the basis of a single strand. Catgut in the raw state naturally shows greater strength than after the severe process of sterilization. The following figures indicate the size and strength of B. & B. sterile catgut:

Number	Breaking strain Pounds	Approximate Diameter
00	5	.012 inch.
0	7	.015 "
1	10	.018 "
2	15	.021 "
3	20	.024 "
4	26	.027 "

For *a ligature which will be more slowly absorbed* than plain sterile catgut, hardening with chromic acid is resorted to. Efforts have been made to grade the absorbability of chromic catgut and establish a chrono-chromic catgut based upon the length of time the gut will re-

sist absorption when embedded in the thigh muscles of rabbits. One of the ablest advocates of this method of grading absorbability says: "Besides considering the difference between human muscle and animal muscle, it must be remembered that not only muscle but other tissues are repaired by suture and each tissue exerts its own peculiar katalytic action. * * * Thus it will be found that a piece of fine '40 day' chromic gut may last five to seven days, and occasionally even twelve days or more, when employed as a skin suture." Another advocate of grading catgut as 10, 20, 30 and 40 day gut says that when "used in the peritoneum or other serous membranes," the gut "can be relied upon to last one-quarter of the time" specified on the label.

As a result of experiments on animals and from clinical observations the following is an approximate average duration of plain catgut in the tissues: *Average duration of plain catgut.* Size 0 lasts 4 days in peritoneum; 7 days in skin; 9 days in muscle; size 3 lasts 8 days in peritoneum; 12 days in skin; 16 days in muscle. *Average duration of medium hard chromic catgut.* Size 0 lasts 8 days in peritoneum; 14 days in skin; 18 days in muscle; size 3 lasts 16 days in peritoneum; 24 days in skin; 30 days in muscle. *Average duration of extra hard chromic catgut.* Size 0 lasts 12 days in peritoneum; 21 days in skin; 27 days in muscle; size 3 lasts 20 days in peritoneum; 30 days in skin; 40 days in muscle.

Iodized catgut is about as durable as medium hard chromic and exerts an antiseptic action.

Formalized pyoktanin catgut is practically as durable as medium hard chromic and exerts an antiseptic action.

Plain pyoktanin catgut is appreciably more durable than plain catgut and is antiseptic.

Silk ligatures are prepared from both twisted and braided silk of the quality best adapted to surgeons' use. Silk put up with needles is sterilized in the same way as catgut; that without needles is subjected to repeated sterilizations by the vacuum and pressure steam process. It is supplied both in hermetically-sealed glass tubes and germ-proof envelopes. The longer lengths on cards are resterilized after putting in envelopes, but it will, of course, be understood that any unused surplus will require sterilization. This, again, is an argument for the "individual" tube or envelope containing little more than will be used at one operation. Unlike catgut, however, silk is easily sterilized and any surplus can be made sterile by boiling in water. Each lot of silk ligatures is tested for sterility in the same way as is catgut.

The size and strength of B. & B. silk ligatures are approximately shown in the following table:

Twisted Silk.			Braided Silk.		
No.	Breaking strain in pounds	Dia. in inches	No.	Breaking strain in pounds	Dia. in inches
1	3½	.010	1	5	.012
3	8	.012	3	10	.017
5	9	.014	5	13	.022
9	10	.017	7	21	.027
12	12	.020	9	30	.033
15	22	.030	12	42	.040

Sterile silkworm gut is a smooth suture material prepared by cleansing and drying under tension the silk-forming gland of the silkworm. The usual length is fourteen inches. In grading, sizes correspond approximately to 0, 1 to 2 catgut. The strength of silkworm gut ranges from eleven to sixteen pounds. It is steam sterilized before putting up and, after sealing, given sterilization under pressure on succeeding days. A convenient package is the bottle holding twenty-five coils. The natural stiffness of the suture is overcome by the antiseptic solution in which it is put up and the gut will be found sufficiently flexible as it comes from the bottle. A dyed silkworm gut is used where it is desired to have a colored suture which can be easily seen.

Sterile horsehair is selected from the strongest black tails obtainable, each strand being tested for strength. It is first thoroughly cleansed with soap and hot water and then sterilized by the vacuum and pressure steam sterilization process both before and after sealing in bottles or germ-proof wrappers. Horse-hair sutures run from fourteen to twenty inches in length, stand a tensile strain of from one and a half to two pounds and vary in size from what would be 00 to 1 on the catgut scale. Horsehair is much employed for superficial sutures, the strain commonly being taken by tension sutures of silkworm gut. The most convenient package of horsehair is the screw cap bottle containing twenty-five individual coils. This makes it unnecessary to remove any more from the bottle than is to be used at one time.

Suture, Tension. See **Sutures in ophthalmic surgery.**

A tension suture for advancement operations. Harold Gifford (*Ophthal. Record*, March, 1916) points out that when the internal rectus is advanced, the tension on the sutures can be fairly well re-

lieved by the customary practice of putting a stitch through the opposite tendon or a fold of conjunctiva and attaching it to the bridge of the nose or to a thread from the outside of the other eye. But when the external rectus is advanced, the eye can not be rotated outward by a thread attached to the internal side of the eye and the skin of the temple, on account of the danger of injury to the cornea.

To meet this difficulty Gifford has for some years been using a suture (ordinary black silk, size D, with two needles) put in as follows: After finishing the advancement operation, a firm hold is obtained with the fixation forceps on the tendon of the internal rectus, and one needle is passed through this and through the center of the free border of one lid and out well below the lashes, at about the junction of the middle and the outer third. The other needle is then passed through a corresponding part of the other lid. The ball is then rotated outward till the insertion of the tendon is about under the points where the lids are penetrated by the thread, and the latter is tied just tightly enough to bring the lids down to the surface of the globe. He removes the stitch after from five to seven days. Sometimes it cuts through the tendon by that time.

For picking up the tendon through the uncut conjunctiva, forceps with sharp projecting teeth are desirable.

Since using this tension suture the writer's advancement results have improved decidedly. It will, he thinks, be found of use no matter what form of advancement or tucking may be employed.

Suture, Twisted. A suture in which pins are passed through the opposite lips of a wound, at right angles to the direction of the wound, and thread, floss or other like material is wound about the pins, crossing them first to one end and then at the other in a figure-of-eight fashion, thus holding the lips of the wound firmly together.

Suture, Uninterrupted. Continuous suture.

Suzione della cataratta. (It.) Suction operation for cataract.

Sviluppo dell'occhio. (It.) Development of the eye.

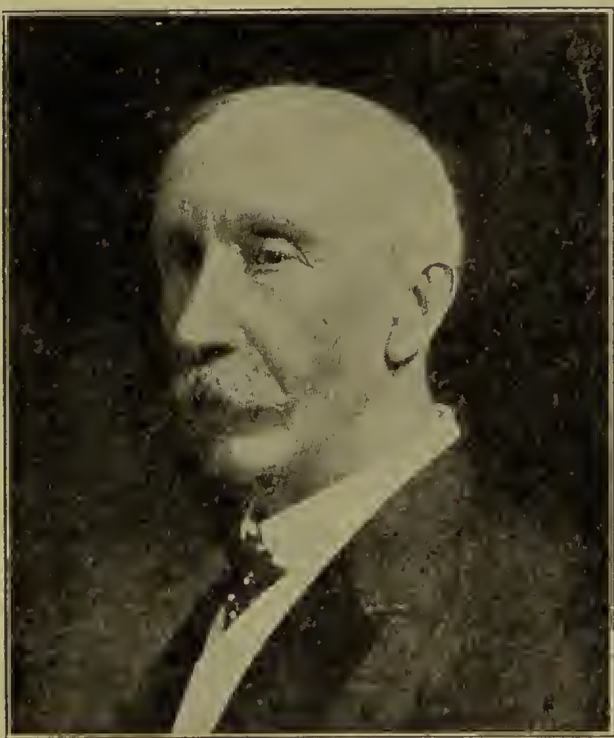
Swabbing the lids. Brushing. Instrumental massage. See **Brossage,** p. 1314, Vol. II of this *Encyclopedia*.

Swallow, The. In ancient Greek and Greco-Roman times, the belief was very firmly fixed that the eyes of a young swallow, if pricked out or even if cut out, would grow again and be as good as ever. In accordance with this belief, and also with knowledge of the actual fact that the vision of the swallow is remarkably acute, the swallow was eaten in various forms as a well-nigh unfailing remedy for numerous ocular affections. Live swallows were often burnt to ashes, and this residuum employed for general weakness of the sight. The brain of

the swallow was thought to be very valuable for "suffusio" (cataract). For epiphora, a swallow was pounded up and laid, either raw or cooked, as a poultice on the forehead. The whole of the swallow was sometimes eaten as a means of increasing the visual acuity, and, for a similar purpose, the ashes of a number of young swallows roasted together with their mother, were sprinkled in the eyes.—(T. H. S.)

Swamp tea. See **Labrador tea,** p. 6918, Vol. IX of this *Encyclopedia.*

Swanzy, Sir Henry Rosborough. A celebrated Irish ophthalmologist, author of the universally employed *"Handbook on Diseases of the Eye, and Their Treatment."* Born in Dublin, Nov. 6, 1844, he studied



Sir Henry R. Swanzy.

at Dublin, Vienna and Berlin, and became assistant at von Graefe's private hospital. He received his M. B. at Dublin University in 1865, and the license of the Royal College of Surgeons of Ireland the next year. In 1866-67 he served in the Prussian army in a medical capacity. Returning to Dublin he at once became famous as an operator, and, in time, surgeon to the National Eye and Ear Infirmary and ophthalmic surgeon at the Adelaide Hospital. In 1873 he was made a Fellow of the Royal College of Surgeons of Ireland. Honors came thick upon him, among them the Bowman Lectureship and the Presidency of the Ophthalmological Society of the United Kingdom. He was also president of the Ophthalmological Section of the British

Medical Association, at its Dublin meeting in 1886. In 1906 he was elected president of the Royal College of Surgeons of Ireland. Very shortly afterward he was knighted. Honorary degrees were conferred upon him by various universities, and in 1913 he was chosen president of the Ophthalmologic Section of the International Medical Congress. However, before the meeting was held, Professor Swanzy died, April 12. At a public meeting convened by The Lord Mayor of Dublin, The Lord Chancellor of Ireland, The Earl of Pembroke, and a number of other gentlemen, "it was unanimously resolved that a permanent memorial should be erected in Dublin to the late Sir Henry R. Swanzy, and that the memorial should, if possible, take the form of completing the Royal Victoria Eye and Ear Hospital to the foundation and construction of which he devoted the best years of his professional life."

Regarding the personality of the man, we quote the following passage from Werner: "Henry Rosborough Swanzy was a man of noble character and dignified bearing. His manner towards strangers might at times have appeared to be somewhat distant and reserved, but on further acquaintance he became all cordiality and affability. To appreciate his sterling qualities, it was necessary to know him intimately and no one who, like myself, had been in close contact with him, working almost daily by his side for close on 30 years, could do otherwise than entertain the very highest admiration for him. He was essentially just and upright and nothing would make him swerve from the path which he considered to be the right one. His opinions were never hastily formed. Everything which he undertook was carefully thought out and considered beforehand, and when once decided upon was carried out with indefatigable energy, perseverance, and constant attention to the smallest details. It is to these characteristics that we chiefly owe the existence of the Royal Victoria Eye Hospital in Dublin, which stands as a splendid and lasting monument to his memory. For it was Sir Henry who conceived the idea of uniting the two eye hospitals known as St. Mark's Ophthalmic Hospital and the National Eye and Ear Infirmary, from the amalgamation of which the present magnificent institution has arisen. It was a source of great pleasure and pride to him that he had been able to accomplish his purpose so successfully, and up to the very last, as secretary to the council, he continued to take the keenest interest in the working of the hospital. He had indeed a positive genius for managing an institution of the kind, and I remember his saying to me on one occasion when walking home after our morning's work, that if he had not been an ophthalmic surgeon he thought he would have made a good hotel manager. His capacity for making things run in a smooth and orderly manner was

largely due to his high sense of duty both as regards himself and others, and if anyone under him failed in this respect he spoke his mind openly and gave his orders peremptorily.

"His wonderful energy and desire to do his best at all times may be illustrated by a few examples. While he was preparing the Bowman lecture on "The Value of Eye Symptoms in the Localisation of Cerebral Disease" he, sitting in the students' benches, attended a complete course of lectures on the anatomy of the brain delivered by his friend the late Professor D. J. Cunningham, in the Trinity College Medical School. Again, just before his death, he had arranged for a series of "grinds" on the theory of Immunity and Anaphylaxis, so as to enable him to appreciate papers on this subject at the International Congress, and he was also taking lessons in French with the view of attending the May meeting of the French Ophthalmological Society, of which he had only recently been elected a member.

"Sir Henry was a very neat and careful operator. During a cataract operation he always insisted that the instruments should be put into his hand by the assistant, believing that the surgeon should never allow his attention to be diverted from the eye of the patient.

"In his moments of relaxation he was charming, always a most agreeable and cheerful companion, with a sense of humor peculiar to himself. He endeared himself to his colleagues, to the hospital staff and to all those who had the good fortune to know him intimately. Personally I always entertained feelings of the greatest regard and friendship for Sir Henry but I did not realize, to the full extent, the depth of my attachment to him until he was no more."

Sir Henry's more important articles and papers are as follows: 1. On Essential Phthisis Bulbi. (*Dub. Quart. Jour.*, 1869.) 2. On von Graefe's Insufficiency of the Internal Recti Muscles. (*Ibid.*, 1870.) 3. Ophthalmic Notes. (*Ibid.*, 1871.) 4. Retinal Hemorrhages, with Detachment of Vitreous Humor. (*Trans. of the Ophth. Soc.*, U. K., 1882.) 5. Tubercle of the Iris. (*Ibid.*, 1882.) 6. Case of Hemiachromatopsie. (*Ibid.*, 1883.)—(T. H. S.)

Sweat bath. Sweating. See **Hydrotherapy**, p. 6080, Vol. VIII and p. 910, Vol. II of this *Encyclopedia*.

Hansell (*Oph. Year-Book*, p. 51, 1909) discusses and illustrates the value of sweating in the treatment of internal affections of the eye. Because of its influence on the heart he has abandoned the use of jaborandi, and prefers dry heat. The patient is placed on a rubber sheet, enveloped in three blankets, surrounded by vessels of hot water, and given a cup of hot fluid to drink. The process should not be continued more than one and one-half hours. The patient may drink a

glass of iced water in the middle of it, and his head should be wrapped in a wet towel, or covered with an ice cap. The patient should remain in bed until the following morning. If the temperature subsequently falls below normal, the time of the baths must be shortened.

Gallenga also believes the cure by hot baths is indicated for various infections and intoxications involving the eye, parenchymatous keratitis, eczematous pannus, uveal inflammations and osteitis or caries of the bones of the orbit. They are contraindicated in acute phlyctenular disease, trachoma, and gray atrophy. They tend to hasten the maturity of cataract.

Sweating, Excessive. See **Hyperidrosis,** p. 6096, Vol. VIII of this *Encyclopedia.*

Kahn (*Oph. Year-Book,* p. 55, 1916) thinks that eye-strain is by far the most frequent cause of reflex neuroses among which he includes insomnia, sleepiness, nightmare, constipation, *excessive sweating* and general weakness. "One-half of all people suffering from eye-strain also suffer from some form of sleep anomaly." He records an enormous percentage of recoveries from correcting glasses.

Sweet's method with x-rays. See **Localization of ocular foreign bodies,** p. 7509, Vol. X of this *Encyclopedia.*

Sweet spirits of nitre. See **Spiritus etheris nitrosi.**

Swelling, Soemmering's crystalline. A supposed annular edema of the lower portion of the lens-capsule after the removal of a cataractous lens.

Swimming-pool conjunctivitis. SWIMMER'S CONJUNCTIVITIS. See p. 3165, Vol. V, of this *Encyclopedia.*

In an article by Gradle (*Ill. Med. Jour.,* February, 1916) he remarks that originally it was an infection thought to resemble trachoma, especially as there were found bodies microscopically identical with the inclusion bodies of Prowaczek.

Brown, of Philadelphia, reported a series of 500 cases occurring in that city in 1914. Corneal complications were absent except in one case thought to be a secondary infection. Gradle saw 18 cases in 1914-15, and made smears, staining for all the bacteria usually found in the conjunctival sacs. None were found that would account for the clinical picture present. Cell inclusion bodies were always found except where silver nitrate had been used.

The disease is usually bilateral; there is moderate photophobia, and a small amount of muco-purulent secretion, particularly at night. Moderate edema of the lids; tarsal conjunctiva slightly swollen and roughened; coarse injection, with individual vessels standing out prominently; no distinct hyperplasia of follicles; conjunctiva of the tran-

sitional folds swollen, with a smooth surface and deep red color; bulbar conjunctiva slightly edematous and swollen; moderate, coarse injection, beginning at the transitional folds and decreasing toward the cornea. The limbus surrounded by a zone of normal appearing conjunctiva; cornea normal.

Under treatment the disease lessens in a week and usually disappears in three weeks. It is apt to remain longest in the transitional folds. If treatment is discontinued too soon a relapse may occur. Gradle applies 1 per cent. silver nitrate once a day, and prescribes 10 per cent. argyrol to be used three times a day. In one case the disease persisted for over six months. The inclusion bodies rapidly disappear under treatment. It cannot be positively said whether these cell inclusions are etiological factors or not.

Sycamore. The North American tree known botanically as *Platanus occidentalis.* Hubbard (*Jour. Oph., Otol. and Laryngology,* Aug., 1914) employs the tincture (?) of sycamore in 4-drop doses as a cure for chalazion, even in long continued and recurrent cases. He speaks very highly of the results.—(T. H. S.)

Sycosis palpebræ marginalis. Disease of the hair follicles apparently confined to the edge of the eyelid.

Sycosis parasitica. SYCOSIS TARSI. BLEPHARITIS ULCEROSA. The hair follicles of the lid are (with the superciliary follicles) occasionally attacked by the fungus *tinea* or *trichophyton tonsurans;* generally both sides (including the lashes) are invaded. The *treatment* consists in extracting all the diseased hairs, cleansing with hydrogen peroxid, followed by a 1:5000 sublimate wash and yellow oxid ointment. See **Blepharitis,** p. 1022, Vol. II of this *Encyclopedia;* also **Tinea tonsurans.**

Sycosis tarsi. See **Sycosis parasitica.**

Symblepharon. ANKYLOBLEPHARON. ANKYLOSYMBLEPHARON. This subject is fully treated on p. 1097, Vol. II, *et seq.;* see, also, **Injuries of the eye,** p. 6342, Vol. VIII of this *Encyclopedia.* To the matter in those sections are here added a few references.

Prevention of symblepharon. Elmer Starr (*Ophthalm. Record,* June, 1915) has devised an effective method for the *prevention of adhesion* between the eyeball and eyelid, after destructive injury to the conjunctiva by corrosive chemicals, etc. The operation consists in dividing the lower eyelid (when this is the one affected) from its margin down to the lowest portion of the cul-de-sac. The incision is made vertically through the center of the lid, and involves all the structures (skin, muscle, tarsal plate, and conjunctiva). The two flaps or halves thus made are turned back and stitched, one to the

side of the nose, the other to the cheek, where they are kept covered with some bland sterile dressing until the injured surfaces have been covered by new mucous membrane; then the cut edges of the lids are "freshened," and stitched together again in their normal position. The result in the majority of cases is complete restoration of the fornix and the unimpaired mobility of the eyeball. By facilitating the dressing of the injured surfaces, and by keeping infectious discharges away from the cornea, it also enhances the prospect of preserving the latter.

W. H. Wilder (*Trans. Sec. Ophth. A. M. A.*, June, 1919) remarks that the surgeon can come to the help of nature and by aiding in the epithelization of eye wounds prevent much of the cicatrization that will inevitably produce great deformity if not checked. As soon as it is evident that the wounded surface is clean and granulation is well under way, attempts should be made to cover the raw surfaces with epithelium, for the sooner this is accomplished the sooner will the formation of cicatricial tissue be checked. The general surgeon, recognizing this principle, covers denuded areas that cannot be accurately apposed as soon as possible with thin layers of epidermis. This can be done at the time of operation if cutaneous tissues have been sacrificed, but in the case of loss of tissue from burns or corrosives, he must wait until it is evident that repair is beginning after the shock to the tissues.

In the case of the injured conjunctiva, the difficulty of accurately implanting thin grafts of epidermis or mucous membrane is greater than would be encountered on most other surfaces of the body. Again, if the eyeball remains, and is not too badly injured to require removal, the integrity of the cornea must be carefully considered in any reparative means to be employed.

These difficulties can be overcome by the use of suitably prepared plates conforming to the shape of the eyeball and to the conjunctival sac to hold the layers of epithelium smoothly in contact with the raw surfaces. The device employed must be such that it will not injure the cornea.

A glass plate or porcelain shell with a curvature like that of the eyeball, as recommended by Morton (*Oph. Rec.*, August, 1898) and May (*Arch. Ophth.*, 182, 1899, and 471, 1901) has been successfully employed. Hotz (*Oph. Rec.*, Nov., 1899) employed a thin lead plate for the purpose of holding the graft in place. H. W. Woodruff (*Ann. Ophth.*, March, 1903) used a sheet of block tin cut to the required size and molded to the proper curvature. But whatever material is used for the support, it is well to have a circular opening in the plate at least the size of the cornea: and to insure the least possible irritation

of the cornea, the plate should be coated with a layer of hard paraffin of a melting point of 130 or higher, if it can be obtained. Wilder (*Journ. A. M. A.* 571, Aug. 25, 1906) first described this device.

Posey (*Oph. Year-Book*, p. 342, 1912) relieved ankyloblepharon and complete symblepharon of the inner third of the lid by an extensive blepharoplasty. The operation was performed in three stages: First, after division of the ankyloblepharon and dissection of the lids from the globe, a skin-flap from the side of the nose was superposed upon the raw surface of the globe; second, some months later, the skin-flap was divided from its pedicular attachment allowing free rotation of the eyeball; third, the inner canthus was restored by excision of the redundant portions of the skin-flap and by uniting the edges of the lids at the canthus.

Roselli adds to the two converging incisions which characterize Guerin's procedure, two diverging ones which are a continuation of the former, taking their departure from the angle where they meet. Loosening and eversion of the flap thus formed, with the subsequent application of a suture, enable him to successfully raise the lower lid.

Frederick Krauss (*Ophthal. Record*, July, 1916) proposes an improvement on the usual procedures for the relief of *extensive symblepharon.* The bulbar defect is covered in part by conjunctival flaps and the palpebral portion by a skin-flap. Much difficulty has been found in retaining the flaps in the position desired. Suturing is unsatisfactory, lead plates are equally so. Krauss found the use of the elevator pulley suture very satisfactory in that it holds the lower lid on the stretch, permitting a larger flap to be used on the inner surface of the lid with good apposition against the globe, and lastly assists in the formation of a deep sulcus, from which the flap does not tend to work out.

The writer illustrates his method by the history of a patient, 25 years old, who was severely burned in his right eye, neck and chest by molten steel five months previously. He presented an extensive symblepharon completely blocking the lower cul-de-sac, except a small area on each side. The cornea through two-thirds of its extent was covered by a thick, fleshy mass continuous with the lower lid. There were several smaller synechiæ in the upper cul-de-sac. The cornea was hazy throughout, allowing only light perception. The eye was uncomfortable as well as unsightly.

The thick, pterygium-like mass was carefully dissected from the cornea and from the eyeball to the depth of the normal cul-de-sac. In the course of this dissection, small isolated areas of conjunctiva were discovered and saved.

A large flap of conjunctiva was loosened on the inner and outer sides of the eyeball. These were necessarily rather short, but were united to cover the eyeball by means of sutures. The bottom of the cul-de-sac and the palpebral wall were covered with a Wolff graft, taken from behind the ear.

The flap was readily retained in position by a skin suture inserted near the center of the upper part of the lower lid, brought out about ⅝ inch away, carried up to the forehead where it was similarly introduced, tying the ends over a piece of gauze. The suture acts as a pulley, allowing as much elevation of the lower lid as may be desired. The graft is pressed between the eyeball and the lower lid and held securely by the large piece of gauze covering the eyeball, over which the above named suture is tied.

The suture in this case was removed in five days, leaving no trace. The healing was excellent and a good cosmetic result was obtained.

Morax (*Annales d'Oculist.*, p. 494, 1917; review in *Am. Journ. of Ophthalm.*, p. 170, 1918) observes that whereas partial symblepharon can generally be managed readily, such is not the case in total symblepharon with complete abolition of the conjunctival sac. The formation of a new cavity for prothesis is a most difficult problem. The tendency to retraction and contraction of the orbital tissues is such that the most extensive and perfect graft suffers retraction, such that the new cavity decreases greatly and may even disappear almost entirely. To obviate this tendency, the author has devised a procedure which consists essentially in the formation of two wide "trap doors," the raw surfaces of which are turned outwards above and below by suturing their edges to the skin after freshening the latter. Wide epidermal grafts from the arm, thigh, or abdominal wall are then applied to the raw surfaces.

At the end of three weeks the "trap doors" are replaced and sutured together at their free margins after freshening. A shell of lead or enamel is placed and allowed to remain between the doors, the bottom of the cavity being now covered with the graft. At the expiration of from six weeks to three months, the palpebral margins are cut and prothesis is possible. The same procedure is applicable where the orbital cavity is still occupied by a globe or stump.

Symblepharon posterius. Symblepharon involving the posterior (peripheral) part of the conjunctival sac (the fold of transition).

Symblepharopterygium. A combination of symblepharon and pterygium; a form of symblepharon in which the lid is joined to the eyeball by a cicatricial band resembling a pterygium.

Symblepharosis. Symblepharon; an adhesion of the eyelids to each other or to the eyeball.

Symbols and designations for geometrical optics. The arbitrary and often inconsistent way of designating different magnitudes in optics, so generally practised by different writers in geometrical optics, is so confusing to the beginner and annoying to the advanced reader that Dr. Hermann Kellner, editor of the *Journal of the Optical Society of America* (Jan., 1917) in collaboration with Prof. J. P. C. Southall, Columbia University, made the following recommendations, which now seem probable of universal adoption. In the first place, it seemed desirable that the type used for the letter of reference should give some indication of the nature of the magnitude it is meant to represent. Hence, choice was made of Roman capital letters for points, lower case italics for linear magnitudes, italic capital letters for reciprocals and Greek lower case letters for angles. Two exceptions from these rules could not be avoided, namely, the use of the λ for the wave length and of the Δ for the optical interval, these departures being justified by universal usage.

The same letter or designation is used for conjugate or similar points or magnitudes on both sides of a refracting surface. They are distinguished from each other by a diacritical mark (′) which denotes that the magnitude so marked lies on the side of the optical system away from the side from which the light comes. For instance: f and f', n and n' are the focal lengths and refractive indices respectively on the left and the right side of the refracting surface, and α and α' the slope angles before and after refraction. Elements of a compound system are distinguished by subscripts counting from the left to the right through the system, for instance r_1, r_2, r_3, . . . r_k would be the first, second, third and k^th^ radius of the system. The symbols referring to the whole system in contradistinction to its components are used without subscripts.

The light is always assumed to enter the optical system from the left side, and the direction from left to right is assumed to be positive.

Distances will be counted positive in the direction of the light, negative in the opposite direction.

Radii are measured from the vertex of the surface to the center. This makes radii of surfaces convex towards the incident light, positive, while the radii of surfaces concave toward the incident light will be negative.

Object and image distances are measured from the vertex of the surface. Focal lengths from the principal points.

Ordinates in object and image planes are positive above and negative below the axis.

Slope angles above the axis are positive when they converge in the direction of the light, negative when they diverge. They take the opposite sign when below the axis.

Designations of points (Roman capital letters)

Focal points	F and F′
Principal points	H and H′
Nodal points	N and N′
Conjugate object and image points	O and O′
Centre of spherical refracting surface	C
Vertex of spherical surface	V

Symbols of magnitudes (Italic lower case)

Index of refraction	n, n'
Wavelength	λ
Radius of curvature of refracting system	r
Focal lengths of optical system	f and f'
Distance from vertex V to focal point F	v and v'
Distance between vertices of two refracting surfaces	d
Distance between vertex of refracting surface and object or image point	u and u'
Incidence height	h
Abscissæ measured from principal points	b and b'
Reduced distance between two principal planes	c
Abscissæ measured from focal points	x and x'
Ordinates of conjugate points	y and y'

Symbol of magnitudes (Italic lower case) continued

In a compound system the distance between the posterior focal point of the first component and the anterior focal point of the second component, the optical interval	Δ
Distance between the focal point of a compound system and the posterior focal point of the second component	e

Reciprocals of magnitudes

are to be designated in the corresponding capital italics thus:

$$U = \frac{1}{u} \qquad X' = \frac{1}{x'} \qquad F = \frac{1}{f} \qquad V = \frac{1}{v}$$

or better still, following Gullstrand, let

$$U = \frac{n}{u} \qquad X' = \frac{n}{x'} \qquad F = \frac{n}{f} \qquad V = \frac{n}{v}$$

denoting by capital italic letters the socalled reduced lengths.

F and V represent quantities of great importance in ophthalmic optics, F is the so-called refraction of a lens, V its vertex refraction. Both are expressed in dioptries (dptr) when f and v are measured in meters.

Angular magnitudes are denoted by lower case Greek letters.

Slope angle .... α and α'
Angle of incidence and refraction (or reflection).... ϑ and ϑ'
Central angle .... φ

Magnifications

Lateral magnification .... **Y**
Axial or depth magnification......................... **X**
Angular magnification .... **A**

The following diagrams are given to supplement the foregoing list of designations.

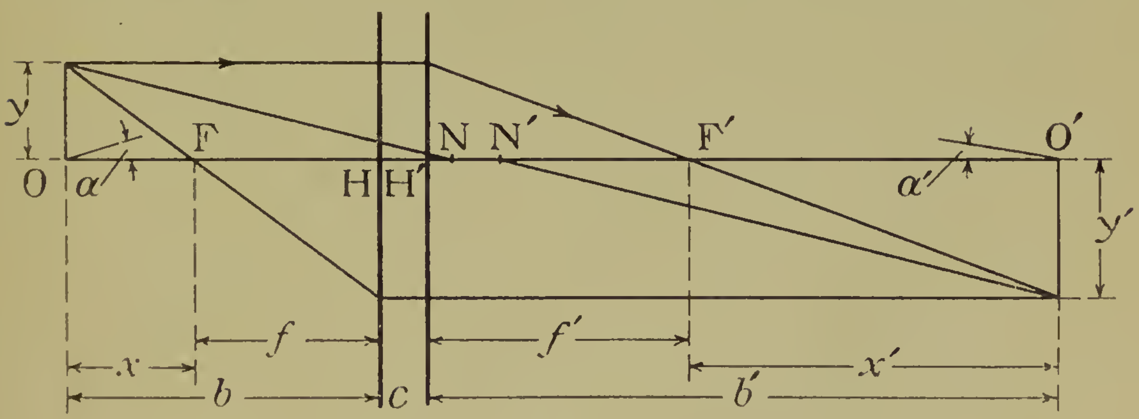


Fig. 1.

An object y, imaged by an optical system represented by the principal points H and H′, the nodel points N and N′, and the focal points F and F′.

$$x \cdot x' = f \cdot f'$$

$$\frac{d\,x'}{d\,x} = -\frac{f \cdot f'}{x^2} = -\frac{x'}{x} = \mathbf{X}$$

$$\frac{y'}{y} = -\frac{f}{x} = -\frac{x'}{f'} = \mathbf{Y}$$

$$\frac{\tan \alpha'}{\tan \alpha} = -\frac{x}{f'} = -\frac{f}{x'} = \mathbf{A}$$

$$y' \, n' \tan \alpha' = y \, n \tan \alpha$$

$$\mathbf{Y\,A} = -\frac{n}{n'} = -\frac{f}{f'}$$

$$\frac{\mathbf{X\,A}}{\mathbf{Y}} = 1$$

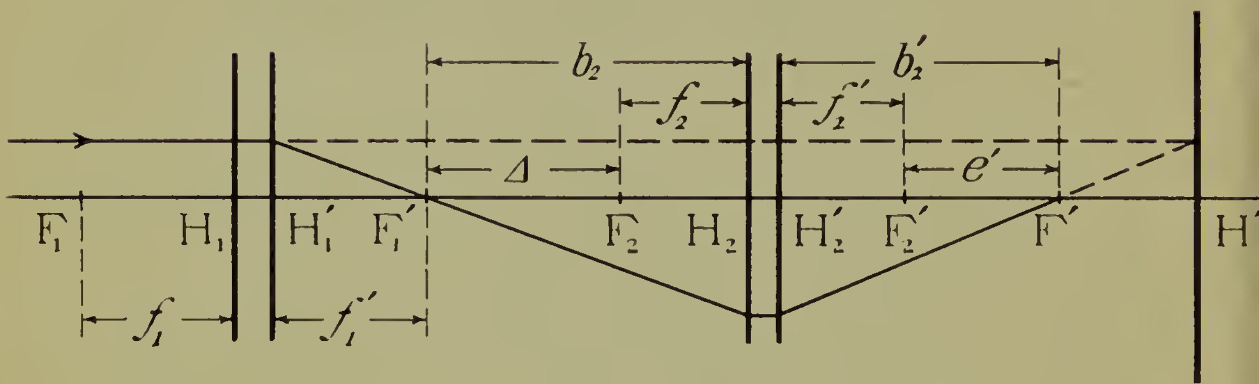


Fig. 2.

A compound system composed of two elements represented by the principal points H_1, H_1' and H_2, H_2', and by the focal points F_1, F_1' and F_2, F_2', the distance F_1', F_2 being the optical interval $\triangle$; object point at $-\infty$.

$$f' = \frac{f_1' f_2}{\triangle} \qquad f = -\frac{f_1 f_2'}{\triangle}$$

$$e' = -\frac{f_2 \cdot f_2'}{\triangle} \qquad e = \frac{f_1 f_1'}{\triangle}$$

$f' = b'$ because $u = \infty$

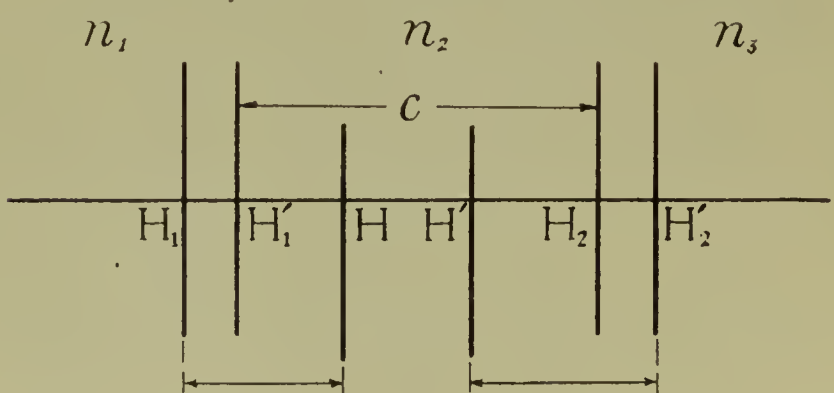


Fig. 3.

The principal planes H, H′ of a compound system, and those of its components H_1, H_1' and H_2, H_2' in their relative locations.

The refracting power of a compound system (Fig. 3) composed of the components having respectively the powers F_1 and F_2 and having a separation between their principal points H_1' and H_2 equal to c, will be

$$F = F_1 F_2 - F_1 F_2 c$$

where $c = \dfrac{H_1 H_2}{n_2}$.

The location of the principal points of the whole system with respect to H_1 and H_2' follows from

$$\frac{H_1 H}{n_1} = c \frac{F_2}{F} \qquad \frac{H_2' H'}{n_3} = - c \frac{F_1}{F}$$

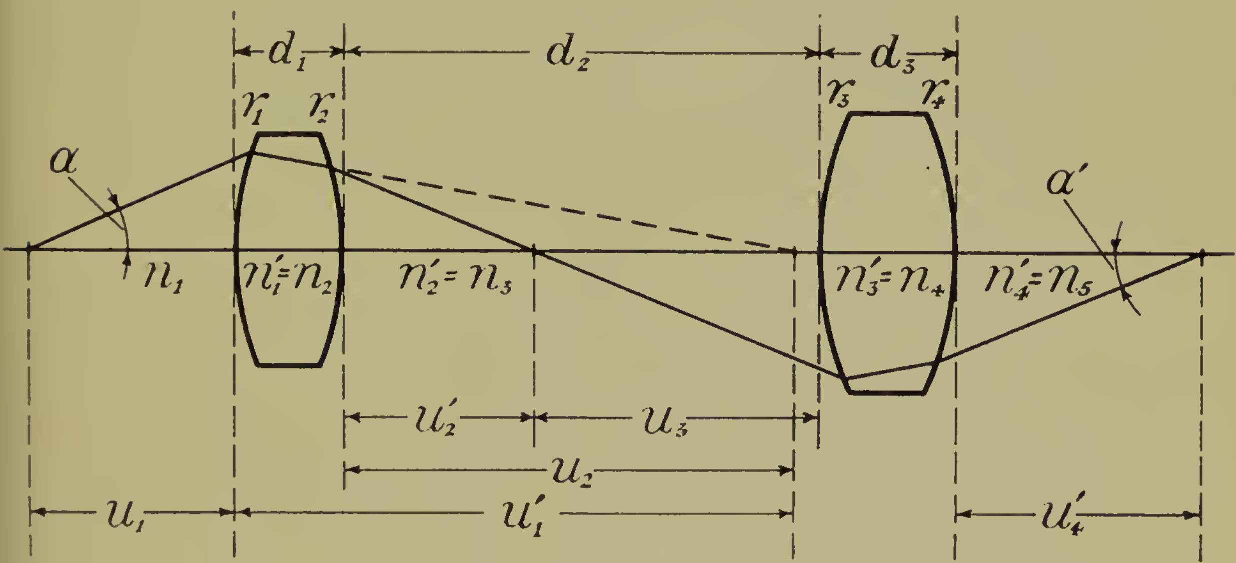


Fig. 4.

Optical imagery through a compound system consisting of two positive lenses of thicknesses d_1 and d_3 respectively, separated by a distance d_2.

In Fig. 4 is

$$u_2 = u_1' - d_1$$
$$u_3 = u_2' - d_2 \text{ etc.}$$
$$n_1' = n_2$$
$$n_2' = n_3 \text{ etc.}$$

when $u_1 = \infty$, u'_4 becomes f'

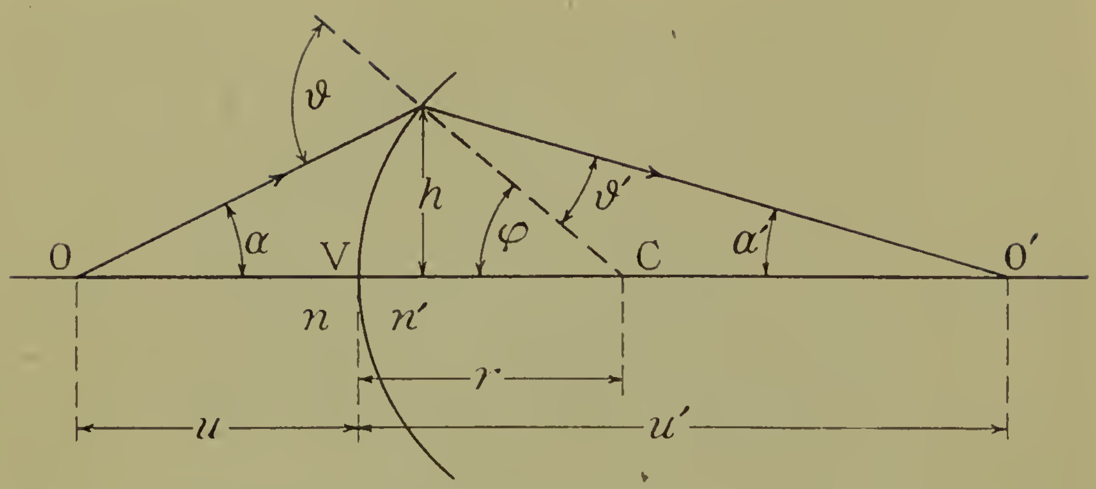


Fig. 5.

Designation of the magnitudes essential in trigonometric calculation of the path of a ray refracted by a spherical surface, the ray path lying in the plane of a principal section.

Fig. 5 is self-explanatory and requires no comment.—(C. F. P.)

Symbols, Pedigree. See **Familial eye affections,** p. 5145, Vol. VII of this *Encyclopedia*.

Symbols, Standard, to designate the optical properties of lenses. In the first number of the *Journal of the Optical Society of America*, January, 1917, there appears an article on optical symbols and designations, written by the editor in collaboration with Prof. James P. C. Southall, Columbia University. The Bausch & Lomb Optical Co., Rochester, N. Y., was the first to recognize the need for the adoption of this logical and systematic nomenclature, which it is expected will eventually be adopted by all optical writers and manufacturers. In the four designations of magnitude, focal length, back focus, power and vertex refraction, it is proposed to use small italic letters for lengths and italic capitals for reciprocals of lengths. Focal length is expressed by the letter f, and back focus by the letter v (from vertex). The reciprocal of the focal length, the power of the lens, is designated by F, where $F = \frac{1}{f}$. The reciprocal of the back focus, the vertex refraction, is designated by V, where $V = \frac{1}{v}$. If f and v are expressed in meters, then both the power, F, and the vertex refraction, V, are expressed in dioptries. For the latter the symbol, dptr, is recommended, in lieu of D hitherto generally used. Therefore, in writing of a lens, the four magnitudes would be specified in the following

manner: It would be said, for example, $f = +125\text{mm}$, $v = +121.2\text{mm}$, $F = +\dfrac{1}{0.125\text{m}}$, or $\dfrac{1000}{125\text{mm}} = +8$ dptr; $V = +\dfrac{1}{0.1212\text{m}}$, or $+\dfrac{1000}{121.2\text{mm}} = +8.25$ dptr. The equations would be read: focal length is + 125mm, back focus is + 121.2mm, power is + 8 dioptries, and vertex refraction is + 8.25 dioptries. It will be observed that the unit of power (the dioptry) and of vertex refraction is identical. These symbols, being easy to remember and to associate with the magnitudes they represent, will make any published optical dissertation at once comprehensive to all scientifically interested readers. The appended terms have also been adopted by the Bausch & Lomb Optical Co., in accordance with their respective definitions, as follows:

Equivalent focal length or focal length: For a lens of infinitesimal thickness, the distance between the image of a far distant object and the lens; for a lens of appreciable thickness, the focal length of the infinitely thin lens which will form the same sized image as the thick lens in question. It is designated by the symbol f.

Back focus: The distance between the image of a far distant object and the center (vertex or pole) of the back surface of a lens. For infinitely thin lenses, back focus and focal length are equal; for thick lenses they are not. Back focus is designated by the symbol v.

Power of a lens: Is the reciprocal of the focal length and is represented by the symbol F, where $F = \dfrac{1}{f}$. If f is expressed in meters, the value of F, given by the equation, will be expressed in dioptries.

Dioptry: The unit of power and of vertex refraction of a lens; the power (or vertex refraction) of a lens whose focal length (or back focus) is one meter.

Vertex refraction: The power of a lens expressed in terms of back focus. Vertex refraction is indicated by the symbol V, where $V = \dfrac{1}{v}$. If the back focus, v, is expressed in meters, then the power V, defined by the equation, will be expressed in dioptries.

Neutralization: The process of finding the power of a lens through combining it with another lens, taken from a series of lenses of known power, until a combination is found which has no power. The two lenses are then said to have the same power but opposite sign. An

unjustifiable process, except for infinitely thin and comparatively flat lenses.

Periscopic: A term originally applied to any saucer-shaped lens At present applied to saucer-shaped lenses which, irrespective of their power, have one surface ground to a curve of 1.25 dptr.

Meniscus: Another general name for saucer-shaped lenses, but at present generally understood to apply to lenses more deeply dished. in which one surface is ground to a 6 dptr. curve regardless of the power of the lens. *A meniscus is not a toric lens.*

Toric lens: A lens having one surface ground with unequal curvatures in different meridians, like the surface of a rubber tire.

Far point: The most remote point at which clear vision is possible with relaxed accommodation.

Near point: The nearest point at which clear vision is possible with maximum accommodation.

Center of rotation: The point within the eyeball about which it rotates as it moves in its socket.

Far point sphere: The summation of all possible positions of the far point as the eyeball rotates in its socket. It will be a portion of a sphere, concave toward the eye, centered in the center of rotation. For a myopic eye the far point sphere lies in front of the head, whereas. for a hyperopic eye it lies behind it.

Near point sphere: The summation of all possible positions of the near point as the eyeball rotates in its socket. It is a portion of a sphere whose center will coincide with the center of rotation of the eye. For a myopic eye the near point will always lie in front of the head, whereas, in hyperopia it may lie in front of the head or behind it.

Field of view: The angular extent of the object space which is imaged upon the retina. For a stationary eye, the part of the total field of view which is imaged upon the fovea and, being very small, is sharply defined. The eyeball, by rotation in its socket, can bring other parts of the object space successively onto the fovea and, hence, the extent of possible rotation of the eyeball defines another field of view which may be called the useful field of view.

Useful field view: For the combination of the eye and eye lens (ophthalmic) the useful field of view is usually limited by the diameter of the lens, and may be defined as the angle subtended by the edge of the lens at the point where the center of rotation is imaged by the lens.

Astigmatism: Of the eye, a state of refraction wherein the eye has different focal lengths, or powers, in different meridians, usually due to unsymmetrical curvature of the surface of the cornea; respecting the image formed by a *lens*, it may be a difference in power in different

meridians due to either intentional or accidental asymmetry in the curvature of the surfaces, or it may be due to the unsymmetrical manner in which a lens refracts a pencil of light obliquely incident upon it.

Distortion: The phenomenon where straight lines in the margin of the field of view appear more or less curved when viewed through an ophthalmic lens.

Chromatic aberration: The phenomenon produced by any lens made of a single piece of glass, since it effects a different focal length for each of the component colors of white light, and manifests itself by causing colored fringes to appear at the edges of objects at the margin of the field, especially when the objects are in sharp contrast with the background; for instance, a window bar seen against a white sky.

Prism-dioptry: A unit of prismatic power; the power of a prism which deflects parallel rays of light 1 cm. in a transverse plane placed at a distance of 1 meter. In order to secure parallel incidence of light, this centimeter-deflection must be increased to 6 cm. in a transverse plane 6 meters from the prism, if the prism is to be measured while sighting through it.

Meter angle: A unit of the convergence of the eyes. If we define the base-line as being the line joining the centers of rotation of the two eyes, then the angle subtended by half the base-line, at a point which is one meter distant from each eye, is a meter angle. See, also, **Symbols and designations for geometrical optics**; as well as **Lenses and prisms** in this *Encyclopedia*.—(C. F. P.)

Symbols, Tension. See p. 1264, Vol. II of this *Encyclopedia.*

Symmetrical opacity. See **Band-shaped keratitis,** p. 877, Vol. I of this *Encyclopedia.*

Sympalmograph. An apparatus for the registration of Lissajou's curves. See p. 3601, Vol. V of this *Encyclopedia.*

Sympathectomy. See p. 5566, Vol. VII, as well as p. 4841, Vol. VI of this *Encyclopedia.*

Sympathetic amblyopia. See **Amblyopia, Reflex,** p. 302, Vol. I of this *Encyclopedia.* In addition, it may here be said that the existence of a pure sympathetic amblyopia is practically denied by J. Keutel (*Klin. Monatsbl. f. Augenheilk.,* 54, p. 250, 1916). He says that of forty-eight cases published as sympathetic amblyopia, Schirmer (Graefe-Saemisch *Handbuch*) weeded out twenty-three, so that twenty-five remained, although some authors did not concede the existence of a sympathetic amblyopia, especially Elschnig, Pfalz and Peters. The writer again critically investigated the cases admitted as such by Schirmer, also the later ones, which are discussed in more or less detail.

His conclusions are that none of the cases can bear severe criticism. Some emphatically prove that functional disturbances of the central nervous system play an important part, aside from the possibility of simulation. It seems, therefore, time to eliminate sympathetic amblyopia as an independent clinical picture from ophthalmologic literature. The explanation in the majority of cases in which after enucleation vision improved is that irritative symptoms—photophobia and lachrymation—ceased in patients who previously had mechanically and functionally diminished vision; or suggestive influences existed, which affected a speedy improvement in the amblyopia and the coincident contraction of the visual field.

Sympathetic ganglia, Excision of. See **Sympathectomy.**

Sympathetic inflammation. See **Sympathetic ophthalmia.**

Sympathetic irritation. See **Sympathetic ophthalmia.**

Sympathetic nervous system, Ocular relations of the. The relations of those portions of the sympathetic system that are chiefly involved in ocular diseases have been set forth, on p. 4841, *et seq.*, Vol. VI of this *Encyclopedia.* See, also, the various **Ganglion** captions.

The principal eye sign of sympathetic paralysis is *miosis* (q. v.), but it may follow various forms of injury. See p. 10753, *et seq.*, Vol. XIV, as well as **Syndrome, Bernard-Horner's.**

M. S. Mayou (*Ophthalmoscope,* June, 1916) reports two cases of paralysis of the sympathetic in which the X-ray showed a cervical rib pressing downward towards the first rib and probably attached to it. In both cases the pupil on the same side was smaller than the other, and did not dilate with shading or cocain. There were also ptosis and diminution of sweating on the same side, as well as enophthalmus. Paralysis of the arm and hand were lacking in these two cases.

T. J. Dimitry (*Ophthalm. Record,* April, 1917) believes that injury to the sympathetic fibres may cause the ptosis and sunken appearance of the lids and prothesis after an enucleation. He points out that we know that in paralysis of the sympathetic we have the palpebral fissure smaller in consequence of changed position of the upper lid; a ptosis of the upper lid in consequence of a paralysis of the smooth muscular fibres of Mueller, which are supplied by the sympathetic: and the appearance at the outer canthus, due to a paralysis of the intrinsic muscle at the raphe palpebralis lateralis and then the neuro-tropic change which produces absorption of the fatty tissues.

The sympathetic and ganglion branches in the orbit are numerous and to attempt to explain their location would add but little in elucidating the argument advanced, but yet it is opportune to review to a

certain extent this sympathetic system of the orbit. The sympathetic nerve supply of the eye and its appendages comes through the superior plexuses which accompany all the arteries distributed to the orbit and surrounding region. The third nerve receives such a branch at its point of division; the fourth nerve as it lies on the wall of the cavernous sinus; the fifth from the Gasserian ganglion, the seventh at the stylomastoid foramen. Sympathetic filaments from the cavernous sinus pass through the sphenoid fissure. Terminal filaments from the carotid and cavernous plexuses entwine round the ophthalmic artery where they accompany subdivisions of the vessels.

We should, consequently, observe special care in removing the eyeball so as to avoid this regrettable accident of sympathetic paralyses.

Sympathetic ophthalmia * (Mackenzie, 1840). REFLEX OR SYMPATHETIC OPHTHALMITIS (Mackenzie, 1854). MIGRATORY OPHTHALMIA (Deutschmann). TRANSFERRED OPHTHALMITIS (Oliver). ANAPHYLACTIC UVEITIS (Elschnig). A chronic inflammation of one eye, chiefly of the uveal tract, caused by or proceeding from disease or injury of the fellow eye.

History. The most complete monograph on this subject has been written by Schirmer [1]; and the reader would do well to consult this, as well as the excellent article by Randolph [2] in Norris and Oliver's *System* for a more complete discussion of the subject, and for particulars of the bibliography up to 1900. According to Schirmer, the first available reference to the fact that internal disease of one eye may depend upon the other was made by Bartisch (1583) who says, speaking of injuries to the eye, that these may be followed by shrinking of the eye-ball which is very painful, "and in this case the other eye is in

* The name first conferred upon this disease was "Sympathetic ophthalmia." It was adopted by Mackenzie, who furnished the first elaborate discussion of the disease, in his *Treatise on the Diseases of the Eye*, 3rd Lond. Ed. of 1840; but in the 4th Edition of 1854 he heads the chapter, "Reflex or Sympathetic Ophthalmitis." The term "Migratory Ophthalmia" (*Ophthalmia migratoria*) was proposed by Deutschmann in the belief that he had proved that the disease migrated from the first eye to the second, by way of the optic nerve and chiasma; but since it is quite uncertain what path is taken in reaching the second eye, this must be rejected. Elschnig's "Anaphylactic Uveitis" and Mackenzie's final preference, "Reflex or Sympathetic Ophthalmitis," should also be thrown out, because they assume knowledge which is not possessed. Transferred ophthalmitis, while it makes no assumption as the path of transference, implies that the disease is an off-shoot of the inflammation in the first eye, and thus rules out the possibility that it is a separate inflammation started *de novo* in the second eye by some such process as anaphylaxis or cytotoxis. "Sympathetic Ophthalmia" is, of course, open to some objection, but in the sense that it denotes a disease in one eye which occurs because of a disease or injury of the other, something can be said for it; and as it has the weight conferred by nearly eighty years of recognition, it is given first place.

[1] Schirmer, Graefe-Saemisch *Handbuch d. ges. Augenhelk.*, 2nd Edition, VI, Kap. VIII, 162.

[2] Randolph, Norris and Oliver's, *System of Diseases of the Eye*, Philadelphia, 3, 721.

great danger." The next two centuries added practically nothing to the comprehension of the subject, although in the works of two or three authors a single sentence indicated some knowledge of the connection. One of these, LeDran [3] (1741), asserted that if, in severe inflammations of the eye, one waited for pus to form, "The patient will lose his sight from the inflammation which will spread to the other eye by way of the optic nerve."

In the first third of the 19th century, several writers (Demours,[4] Wardrop,[5] Lawrence [6]) showed clearly that they recognized the existence of sympathetic disease; and in 1840 * Mackenzie of Edinburg (who merely mentioned it in his previous editions), in the third edition of his famous *Treatise on the Diseases of the Eye* (pp. 523-534), first named the disease and gave the first formal description of it; outlining its characteristics with a fullness and accuracy which has scarcely been excelled. In this fourth edition, where the description is slightly fuller than in the third, he speaks of the disease as an inflam-

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[3] LeDran, cited by Randolph, 721.

[4] Demours, *Traite des Maladies des Yeux,* Paris, 1818, I, 360; II, 504-509.

[5] Wardrop, *Morbid Anatomy of the Eye*, London, 1818, II, 139.

[6] Lawrence, *Treat. Dis. Eye*, London, 1833, 117-120.

* An interesting misconception as to the date of Mackenzie's most important publication has been handed down from father to son after the familiar manner of bibliographers. The date given by de Wecker, in the first edition of Graefe-Saemisch, and by Randolph, is 1844. This, however, was merely the date of the first French translation of the 3rd London Edition. Schirmer erroneously gives the date of the 3rd edition as 1839, and further errs in stating that the classic description first appeared in the edition of 1835. Even the mighty Hirschberg falls for this tradition, and refers to the date as 1844 "or better 1835." The fact is that Mackenzie's first edition of 1830, under the head of *Traumatic Ophthalmiæ*, p. 30, says: "We sometimes meet with severe sympathetic inflammation in the eye which has not received the injury." That is all in this edition. In the edition of 1835, p. 560, he says: "We sometimes meet with severe sympathetic inflammation in the eye which has not received the injury, especially in subjects of scrofulous constitution. For instance, a patient applied at the Glasgow Eye Infirmary with severe iritis in the right eye, brought on in consequence of an accidental and destructive laceration of the left." This is also under the heading Traumatic Ophthalmiæ and is all that this edition contains on the subject. In the edition of 1840 for which Mackenzie wrote the preface in October, 1839, there first appears, p. 523, the name "Sympathetic Ophthalmia," followed by the classic account of the disease which is so commonly quoted. The edition of 1854, which the writer has seen in the American copy only, contains only a few changes, most of them unimportant and some of them for the worse; as, for instance, the change of title from Sympathetic Ophthalmia to "Reflex or Sympathetic Ophthalmitis." There is also a decided slip-back in the description of the mode of transmission, which he made, evidently, under the increasing tendency to ascribe phlogogenic powers to reflex nervous impulses. In the 1840 edition. p. 532, he says: "It is extremely probable that the retina of the injured eye is in a state of inflammation, which is propagated along the corresponding optic nerve to the chiasma, and that thence *the inflammatory action* is reflected to the retina of the opposite eye, along its optic nerve." In the 1854 edition, the sentence is the same up to the word *chiasma;* the remainder being, "And that thence *the irritation which gives rise to inflammation,* is reflected in the retina of the opposite eye along its optic nerve." [Italics H. G.'s.]

mation "commencing in the retina, but gradually involving the whole of the internal structures of the eye-ball, especially the iris, crystalline and vitreous body; coming on, generally, in five or six weeks after an injury to the opposite eye, and terminating most frequently in atrophy and total amaurosis of the eye secondarily affected." He says that the second eye is generally more completely blinded than the first. While admitting that other injuries than penetrating wounds may cause it, he regards penetrating wounds, particularly those involving the ciliary region with prolapse of the iris, as the chief cause. His belief that the disease begins in the retina is based on the fact that dimness of sight is the first symptom; this being rapidly followed by circum-corneal redness. As to the method of transference, he believed that while both the blood vessels and the ciliary nerves might play a rôle, the chief medium was the optic nerve and the chiasma. He says: (Blanchard and Lea, p. 579, American Ed., 1855) "It is extremely probable that the retina of the injured eye is in a state of inflammation, which is propagated along the corresponding optic nerve to the chiasma, and that thence the irritation which gives rise to inflammation, is reflected to the retina of the opposite eye, along its optic nerve." In the matter of treatment, beside the ordinary antiphlogistics, especially mercury, he refers to Wardrop. The latter states (*loc. cit.*) that there is an inflammation of the eyes of horses which usually affects one eye and then the other, sooner or later destroying the vision. Farriers have noticed that if the first eye suppurates and sinks in, the disease does not attack the other or subsides if it had commenced in it. "They therefore adopt the practice of destroying the diseased eye in order to save the other." This was generally done by putting lime between the eye lids, or thrusting a nail into the eye to excite suppuration. Wardrop attained the same end by making an incision, through which he discharged the lens and vitreous. Though Wardrop performed this only in horses, he suggested that it might be tried in some diseases of the human eye which followed a similar course. Mackenzie says that Barton, of Manchester, had adopted Wardrop's practice for the purpose of ridding the eye of pieces of percussion caps; cutting away a large corneal flap and poulticing the eye to produce suppuration; while Crompton [7] recommends Barton's procedure as a treatment and prophylaxis for sympathetic ophthalmia, Mackenzie agrees with this idea without apparently having followed it himself.

Mackenzie is quoted thus freely because his contribution was truly epoch-making and, taken together with the writings of Wardrop.

[7] Crompton, *Lond. Med. Gazette*, 21, 175.

Lawrence, Crompton and especially Prichard [8] and Critchett [9] who in 1854 and 1863, respectively, urged enucleation as a curative and preventive for sympathetic ophthalmia; it established on British soil the firm and enduring foundations of our knowledge of the disease. In later years, however, when advance had to be made through the channels of experimental and microscopic research, it became, as will be seen, largely a German province.

On the continent, beside its recognition by Demours, sympathetic ophthalmia was evidently known to v. Ammon,[10] 1838; and especially to Himly,[11] 1843; who although he mentioned it only in a brief paragraph, referred it to penetrating wounds and suggested that it might result from an insidious neuritis carried to the second eye by way of the optic nerves and chiasma. Up to about 1860, however, continental ideas on the subject were quite vague, as shown by the fact that it is not mentioned in Demarres' text book, 1853; while Arlt [12] gives it a few lines without any specific name nor mention of Mackenzie; dismissing the question of special treatment with the recommendation that protection and rest were the most important things; and v. Graefe [13] was offering, in the line of treatment, the introduction of a seton to produce suppuration in the first eye or the performance of an iridectomy. In the next few years, however, knowledge of sympathetic ophthalmia seems to have made rapid progress, so that at the Heidelberg Congress of 1863, the subject was discussed in general from the standpoint of the British school, with the exception that the tendency was toward the acceptance of the theory that transference occurred through reflex action by way of the ciliary nerves. The subsequent history of the question is so bound up with the developments of theory, pathology and treatment, that it will be given no further discussion except under those heads.

Clinical symptoms of sympathetic ophthalmia. While some of the older works and some modern ones convey the idea that sympathetic ophthalmia is preceded by a series of premonitory symptoms, generally included under the name of *sympathetic irritation,* it can not be too strongly insisted (as was first done by Donders [14]) that there is a sharp and radical distinction between sympathetic irritation and sympathetic ophthalmia. The former is a purely reflex disturbance, showing itself

[8] Prichard, *Journ. Brit. Med. Ass'n,* 1854, 909.
[9] Critchett, *Klin. Monatsbl. f. Augenheilk.,* 1863, Heidelberg Supplement.
[10] v. Ammon, cit. by Randolph, 722.
[11] Himly, cit. by Schirmer, 166.
[12] Arlt, *Krankheit d. Aug.,* II, 50-52.
[13] v. Graefe, *Arch. für Oph.,* 3, 2, 444.
[14] Donders, cit. by Randolph, 735.

in slight photophobia and lachrymation, difficulty in using the eye, and sometimes, transient spells of amblyopia. Of itself, it never produces true inflammation even where it persists for months or years. Whether or not the condition of the blood vessels produced by this irritation may favor metastasis from germs in the circulation, or may aggravate an infection already started is an open question. Perhaps the most important reason for separating sympathetic irritation from sympathetic ophthalmia is the fact that in cases of genuine sympathetic ophthalmia which are under careful observation from the start, there are generally no premonitory symptoms of irritation. Sympathetic irritation is, practically always, promptly cured by removing the other eye or the irritation in it; while in well developed sympathetic ophthalmia an immediate improvement from enucleation of the other eye is generally either absent, slight, or temporary. Simple sympathetic papillo-retinitis (considered later), while not, strictly speaking, sympathetic ophthalmia, might be considered an exception to the last statement, since it seems to be promptly cured by contralateral enucleation.

Sympathetic irritation is most commonly produced by corneal troubles, such as superficial foreign bodies or keratitis, but it may go with any painful affection of the other eye.

In genuine sympathetic ophthalmia the first symptom, as pointed out by Mackenzie, is dimness of sight; and in this opinion the writer concurs absolutely. This comes on insidiously without pain or premonitory symptoms. Within twenty-four hours, however, there is generally added a very slight circum-corneal congestion, with a few fine deposits on Descemet and very slight iritic adhesions. If at this stage the fundus is examined, a more or less pronounced blurring of the disc can frequently be seen; and in one of the writer's cases a small patch of retinal exudate was found a little beyond both the outer and inner margin of the disc. Unless the proper treatment is now adopted, and in some cases in spite of it, the adhesions become firmer, deposits on Descemet increase, with complete occlusion and seclusion of the small pupil, and iris bombé: while if the pupil has been partially dilated, peripheral adhesions form later, binding nearly the entire posterior surface of the iris to the lens. The iris meanwhile assumes the appearance common in most cases of chronic iritis; becoming discolored, with blurring of its delicate surface outlines and finally undergoing a certain amount of atrophy. In rare cases, small, grayish-yellow nodules suggesting tuberculosis appear in the iris. If the pupil remains clear enough to permit an examination of the fundus, the vitreous shows fine opacities and the blurring of the nerve sometimes becomes more pronounced; although, on account of the opacities

on the posterior surface of the cornea and in the vitreous, this is hard to evaluate; and the nerve may well appear to be blurry when it really is not so. If the disease is arrested early enough, so that a reasonably clear view of the fundus can be obtained after some weeks, a significant fundus change which the author regards as the most characteristic macroscopic sign, can frequently be observed. This is a *sympathetic chorio-retinitis,* first noted by v. Graefe,[15] and described more fully by Eversbusch,[16] Hirschberg,[17] Haab,[18] and others; occurring in the form of small roundish, sharply-defined spots, about 1/10 to 1/5 disk-breadths across; yellowish-red, yellowish-white or at the stage generally seen, whitish; with, or more commonly without, a slight pigment ring. These may occur scattered about in the middle or outer periphery; or there may be only one or two small groups in the whole fundus. While they generally appear after some months, the writer has seen them within six weeks after the beginning of the sympathetic ophthalmia. If the interior of the eye were observable in the later stages of the severer cases, such spots would doubtless be found scattered throughout the fundus, or merged into larger spots. Hirschberg has found similar spots in the first eye. Eversbusch [19] and Alt [20] have seen some of them disappear. More rarely, the spots show no pigment at the periphery, but have a little at the center. Occasionally the macular region shows slight pigmentary changes, which, however, affect the sight little or not at all.

In an unusual case reported in Randolph's monograph (p. 768), the main changes were chiefly near the center of the fundus, and consisted of irregular patches of brownish pigment with small oval areas of atrophy, each showing a little pigment in its center; also a general pallor of the fundus for one or two disk-breadths around the nerve.

As the disease progresses, the congestion, which generally does not get very severe, continues; glaucoma from seclusion of the pupil or blocking of Fontana's spaces, occurs not infrequently; and while this is generally not accompanied by much pain, in the later stages it sometimes causes so much distress that the eye has to be removed.

Still later, the anterior chamber frequently gets shallow; cataract develops; the eye-ball shrinks to some extent and sight is entirely lost through disorganization and detachment of the retina. The latter is seldom seen except after enucleation; although in at least three cases.

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[15] v. Graefe, *Arch. für Oph.,* 12, 2, 149.
[16] Eversbusch, *Mittheilung. a. d. Univ. Augenklinik z. München,* I, 329.
[17] Hirschberg, *Centralbl. f. prakt. Aug.,* 1895, 80.
[18] Haab, *Trans, Heidelberg Oph. Soc.,* 1897, 165.
[19] Eversbusch, *Trans. Heidelberg Oph. Soc.,* 1897, disc.
[20] Alt, *Journ. Am. Med. Ass'n,* 1912, Sept. 21.

(Axenfeld[21]), (Leber[22]), (Komoto[23]), it occurred as a transient feature in a comparatively early stage. Remissions and recurrences of the inflammatory symptoms, sometimes extending over several years, occur in some cases. In quite a number of cases, especially where the eye has received a certain amount of well directed treatment, the inflammation comes to a standstill before the sight is entirely destroyed; the eye retaining some useful vision, unless the lens has become opaque; or having good projection where a cataract has developed. When proper treatment is started soon after the beginning of the disease, a relative cure is not uncommon; normal or nearly normal vision being frequently retained.

In cases complicated with glaucoma, the eye may go blind from the increased pressure, even though the inflammation has come to a standstill.

Milder cases of sympathetic ophthalmia occur more frequently than was formerly supposed. These take the form of so-called serous iritis, often with papillitis; and Schirmer seems to think that even without treatment the disease may remain in the purely serous stage. In very rare cases, the inflammation remains confined to the papilla, retina and choroid (Schirmer, p. 80).

Subjective symptoms, aside from the loss of sight, are not usually severe. While iritic pain sometimes occurs, it usually is moderate; very severe pain seldom occurring except as a result of glaucoma, and even then it is not common. In addition to the loss of sight which is frequently noticed as the first sign of the disease, Speelers[24] claims that amblyopia with central scotoma is an almost constant forerunner of sympathetic ophthalmia, and there have been some reports of an enlargement of the blind spot, as the first warning of the onset of sympathetic ophthalmia.

Other manifestations of sympathetic disease of the most varied and sometimes absurd character were frequently recorded from the years 1860 to 1880; glaucoma, cataract, conjunctivitis, mixed up with all the symptoms of sympathetic irritation, were often reported as manifestations of sympathetic ophthalmia; but at present the tendency is to cross these off except as secondary results of real sympathetic ophthalmia; the only ones which remain to receive serious consideration being sympathetic papillo-retinitis, sympathetic amblyopia and sympathetic optic atrophy.

Sympathetic papillo-retinitis. It is difficult to say how often visible

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21 Axenfeld, *Klin.-Monatsbl. f. Augenheilk.,* Beilageheft, 113.
22 Leber, reported by Schirmer, p. 95.
23 Komoto, *Klin. Monatsbl. f. Augenheilk.,* April, 1912, 502.
24 Speelers, cit. by Weekers, *Arch. d'Oph.,* 1912, 421.

changes in the optic disc occur in sympathetic ophthalmia because in so many of the cases the media are so opaque when they are first seen. The experience of the writer leads him to believe that it is a frequent symptom which, in the eyes that are saved, generally clears up without leaving any trace; while in the eyes which are more seriously affected, the media remain too opaque to permit any ophthalmoscopic examination. Only rarely in eyes with reasonably clear media, as in the cases of Leber cited above, does the swelling of the nerve and the inflammation of the surrounding retina attain a very marked degree: and how frequently this occurs in the numerous eyes that are lost is difficult to decide, on account of the infrequency with which such eyes are microscopically examined. Aside from optic neuritis as one of the features of the commoner form of sympathetic ophthalmia, cases have been reported in which papillo-retinitis of a moderate degree, with more or less dimness of sight, has been the only symptom of sympathetic disease. These cases have all promptly subsided upon enucleation of the exciting eye; and as Deutschmann [25] and Alt [26] have shown that irritating substances injected into the vitreous of one eye of rabbits could be carried over to the second eye by way of the lymph spaces surrounding the optic nerve and chiasm, the writer was lead to suggest in 1886, that, in some cases at least, an optic neuritis and even a slight iritis, might be caused by the carrying over from the first eye of bacterial products before the germs themselves had had time to reach the second eye. The promptness with which enucleation sometimes improves a beginning sympathetic ophthalmia might thus be accounted for, although the possible influence of ciliary irritation must also be reckoned with in this connection. In the only too frequent cases where the improvement of sympathetic ophthalmia produced by enucleation is merely temporary, it must be assumed that the germs, in small quantities, had also reached the second eye and that their action was being reinforced by the toxins.

Schirmer, on the theory that simple papillo-retinitis is always toxinic, states that it is always promptly cured by enucleation and has never been observed after enucleation. These statements may be true up to date, but that they are not necessarily so is indicated by the report of at least two cases of papillo-retinitis after evisceration. Theoretically there is no reason why a mild infection should not be halted at the papilla of the second eye, and the records of sympathetic ophthalmia after enucleation are not complete enough to make one feel certain that simple papillitis may not also have occurred in some such cases.

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25 Deutschmann, *Arch. für Oph.*, 30, 3, 78.
26 Alt, *Am. Journ. Oph.*, 1, 97.

Sympathetic optic nerve atrophy. It is certain, even without microscopic proof, that eyes which have lost their sight by sympathetic ophthalmia must also be the subject of secondary atrophy of the optic nerve. Satisfactory clinical evidence of the occurrence of sympathetic optic nerve atrophy, without the involvement of other portions of the eye, seems to have been given only in the cases of Rosenmeyer *[27] and Consiglio.[28] In the former, several weeks after the enucleation of an eye with perforating injury and severe irido-choroiditis, the sight of the other eye went down gradually to fingers at two metres, with beginning pallor of the temporal edges of the disc. Five years later the vision was found to be the same with the disc white and slightly excavated. There were no other signs of disease of the nervous system but severe headache which appeared early in the case still appeared from time to time. In the case of Consiglio, the explosion of a dynamite cartridge destroyed the sight of the left eye and injured the other slightly. The sight of the right eye, however, gradually failed to counting fingers in the course of the next five weeks, with no objective sign to account for it except a slight pallor of the disk. Enucleation and two months' treatment produced very little improvement. Consiglio attributes the loss of sight to sympathetic retro-bulbar neuritis. While, in view of the uniqueness of these cases, the atrophy may well have been a coincidence resulting from sinus disease, there is nothing improbable in the supposition that optic nerve atrophy may occur from sympathetic retro-bulbar neuritis. In neither of the above cases was the pathology of the enucleated eye characteristic. That the sight may be lost from neuritis of this character is indicated by the two cases of the writers, in which after operative prolapse of the iris with considerable inflammation, the second eye lost all perception of light, with such slight anterior inflammatory signs as to entirely escape the observation of the patient and her family. In both these cases, however, the presence of cataract prevented the examination of the disc.

Under the head of *sympathetic amblyopia,* Nuel [29] has reported a number of cases of visual disturbance in one eye, after serious injury or disease of the other. A large share of these, in which the disc remained unaltered, would commonly be considered cases of sympathetic irritation; while in others in which some pallor of the disc was observed, it may be that, as was possible in Rosenmeyer's case.

* F. Deutschmann, on grounds with which the writer is unacquainted, states that this patient of Rosenmeyer's was a malingerer.

[27] Rosenmeyer, *Arch. für Augenheilk.*, 28, 71.

[28] Consiglio, *Beit. z. Aug.*, Heft 63.

[29] Nuel, *Arch. d'Oph.*, 1897, 145.

there was some sympathetic retro-bulbar neuritis. The same may be said of a case reported by Perlman.[30]

Pathology of sympathetic ophthalmia.

Pathologically, sympathetic opthalmia occupies a somewhat unique position, inasmuch as the vast majority of the writings on the subject concern themselves, not with the condition of the affected organ, but with that of the other eye. This for the very obvious reason that an eye with sympathetic ophthalmia is practically never enucleated during life, except in the extremely rare cases in which the operation is necessitated on account of pain; while the cases in which one is fortunate enough to get such an eye at a post mortem, are few and far between.

Conditions found in sympathogenic eyes. The term sympathogenic * is used by the writer for the sake of brevity, to denote eyes that have caused sympathetic ophthalmia. By sympathogenic inflammation is meant the characteristic type of inflammation commonly found in such eyes.

In the vast majority of sympathogenic eyes, the greater part of the uveal tract is found to be the seat of an infiltration with small mononuclear cells (lymphocytes); more or less nodal in character; the grouping not infrequently occurring around blood vessels. In the later stages these nodes become fused into a general lymphocytic thickening (often so great that, in sections, it can plainly be seen with the naked eye), with groups of epithelioid and sometimes of giant cells. In the latest stages of the disease this infiltration mostly disappears and is replaced by a shrunken layer of pigmented connective

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[30] Perlmann, *Arch. für Oph.*, 84, 39.

* The writer has used this term because the continental nomenclature makes it necessary to have some word to designate the inflammation of the first eye. Following the pernicious custom of the French who, for some unexplained reason, began, about 1890, to speak of the *first* eye as *l'oeil sympathisant*, and the *second* as the *l'oeil sympathisé*. Schirmer calls the first eye, das sympathisirende, and the second. das sympathiserte Auge. He calls the inflammation in the first eye, die sympathisirende Entzündung; and also uses the same term for this form of inflammation when it occurs in eyes that have *not* caused sympathetic ophthalmia. An eye which has this form of inflammation without involvement of the second eye, is spoken of as sympathiefähig, meaning, capable of causing sympathy. While a few Germans have protested vainly against this absurd nomenclature, it has been adopted, almost universally, in the great mass of continental literature on the subject that has appeared since 1900; and the abuse is spreading into our literature, by way of reviews and translations of continental works. Both natives, and foreigners writing English, frequently fall into this error; the former because they do not know the German custom, the latter because they do not know the English. Hence the use of "sympathogenic" for the first eye and its form of inflammation.

tissue; many of the vessels having meanwhile been obliterated by hyaloid degeneration. In the stage at which such eyes are commonly examined, the infiltration of the iris and ciliary body is apt to be somewhat diffuse, probably through a merging of the original foci of infiltration; while in the choroid, the nodal character of the inflammation is more pronounced. The capillary layer of the choroid is apt to be affected only in the later stages of the disease; while the outer choroidal layers, including the supra-choroidal space, are soon affected. This also applies to vessels penetrating the sclera, which frequently show an infiltration about them. In rare cases, the infiltration penetrates the sclera and appears on its outer surface. A fibrino-plastic exudate is almost always present on the free surface of the iris and the ciliary processes, tending to form firm membranes which unite the whole posterior surface of the iris to the lens and to extend over much of the back surface of the lens which becomes opaque in severe cases and not infrequently in more moderate ones. In the early stages the retina is generally not appreciably affected, lymphocytic infiltration being absent except around some of the vessels; but as the disease progresses it undergoes disorganization and atrophy from the obliteration of the choroidal vessels and from the detachment which generally occurs. The vitreous is affected quite early and unless the disease is checked it is largely destroyed. The peripheral end of the optic nerve almost always shows a moderate diffuse lymphocytic infiltration, diminishing rapidly toward the brain. In the rare cases in which the posterior portion of the nerve and the chiasm have been examined, slight infiltration along the pial coverings has been found. In a few cases, characteristic lymphocytic foci have been found in the peripheral end of the optic nerve.

The above is a brief summary of the microscopic researches of Brailey,[31] Schirmer,[32] Uhr,[33] Ruge,[34] Fuchs,[35] E. V. L. Brown,[36] and others, but there is a tendency to ignore the work of the earlier men and to give undue credit to the work of Fuchs who, while confirming their general observations, added the conclusions that the somewhat nodular lymphocytic infiltration, with a tendency to the production of epithelioid and giant cells, was absolutely characteristic of this disease; and, second, that the fibrino-plastic inflammation which is practically always present, does not belong to sympathetic ophthalmia proper but

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[31] Brailey, *Trans. Internat. Med. Cong.*, Berlin, 1890, 112.
[32] Schirmer, 101.
[33] Uhr, cit. by Elschnig, *Arch. für Oph.*, 78, 566.
[34] Ruge, *Arch. für Oph.*, Vols. 57, 65.
[35] Fuchs, *Arch. für Oph.*, 61, 2.
[36] E. V. L. Brown, *Arch. für Augenheilk.*, 59, p. 60.

is due to a secondary or mixed infection. With regard to his first contention, the majority of subsequent observers agree, but their negative results as to the occurrence of sympathetic ophthalmia without the typical picture, can not be held to disprove the positive results of Ruge (*loc. cit.*), Gilbert,[37] Watanabe,[38] and others, who have found intermediate forms between the typical sympathogenic inflammation and that which frequently occurs in non-sympathogenic eyes. Fuchs himself admits that both giant cells and epithelioid cells may be lacking in sympathogenic eyes; and that in the early stages the only characteristic thing is the nodal infiltration with lymphocytes. But this without question has been observed by other men in non-sympathogenic inflammations including anaphylactic reactions and the inflammation produced by Guillery [39] with various toxic products.

Fuchs' second conclusion, that the fibro-plastic exudate which is practically always found on the iris and ciliary processes of the first eye, has still less to say for itself. Fuchs bases this claim on the fact that the tendency to plasticity rarely shows in the choroid; and on his statement that the few eyes with sympathetic ophthalmia (i. e., second eyes) which have been sectioned, show that plastic exudate occurs only exceptionally in such eyes. The lack of plasticity in the choroid probably depends upon its lack of free surface, but the evidence of the second eye on this point is certainly of the greatest value; because, in it, a mixed infection can generally be ruled out; and if the inflammation in such eyes practically never showed a tendency to plasticity it would be a strong point in favor of Fuchs' contention. An impartial examination of the records, however, shows that of the ten sympathetic eyes upon which Fuchs bases his statement, together with one other described by Ruge, four showed no plastic exudate; three showed it to some extent; while four showed it to a marked degree. Add to this the commonly observed fact that sympathetic ophthalmia clinically, is, in most cases, a markedly plastic inflammation and it becomes difficult to understand how anyone could claim that this tendency must always be the result of a mixed infection.

But while Fuchs' main facts are not new, and his two main conclusions are open to dispute, there can be no doubt that he has rendered definite service by his method of presenting the argument for the specific character of the sympathogenic inflammation. Out of two hundred eyes enucleated for various causes he was able to pick out twenty-nine (his table gives 35) of which, without knowing their histories,

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37 Gilbert, *Arch. für Oph.*, 77, 296.
38 Watanabe, *Klin. Monatsbl. f. Augenheilk.*, Aug., 1910.
39 Guillery, *Arch. f. Augenheilk.*, Vols. 68, 72, 74, 76.

from the microscopical, or sometimes from the macroscopical findings alone, he felt justified in saying: These are sympathogenic eyes (i. e., they have caused sympathetic ophthalmia); and the event proved him to be correct in all but one case. While some subsequent observers probably have gone too far in insisting that an irido-choroiditis which clinical evidence would class as sympathetic, must be thrown out of court unless the first eye is found to show the main characteristics of sympathogenic inflammation; there can be no question that in a doubtful case, the microscopic findings in the first eye are of the greatest importance.

One of the arguments raised against the strictly specific character of the sympathogenic type of uveitis is that it is sometimes found in eyes from patients in whom the second eye has never become inflamed; but one would certainly expect to find cases in which the specific type of inflammation had begun in the first eye, but where it had not yet reached the second eye, at the time of enucleation.

Another important fact which we owe to Fuchs is that typical sympathogenic changes have been recorded, particularly by Botteri [40] and Meller,[41] in eyes which had never been subject to serious injury; and where nothing in the history would ordinarily raise the question of sympathy. These eyes clinically, have, generally, shown the type of disease known as chronic irido-choroiditis or malignant uveitis, in which the extreme obstinancy of the symptoms and the generally disastrous results strongly suggest the sympathetic form of uveitis. This together with the occurrence of sympathetic ophthalmia with sarcoma of the first eye has led Meller to propose his endogenous theory; according to which such cases are due to the same germ which causes sympathetic ophthalmia, the difference being that instead of gaining access to the eye through a penetrating wound, it has reached the general circulation through some other port, such as an abrasion of the skin or of some mucous membrane. (See sub-section, *Theories.*)

It should be noted as opposed to the current notion that the infiltration in sympathetic ophthalmia is primarily overwhelmingly lymphocytic, that some observers (F. Deutschmann,[42] Jane McIlroy,[43] and Domann [44]) claim that a large part of the infiltration is made up of plasma cells. The fact that this has not previously been discovered, may perhaps be explained, as pointed out by McIlroy on the ground that the eyes examined by earlier observers have generally been pre-

[40] Botteri, *Arch. für Oph.*, 69, 172.
[41] Meller, *Zeit. für Augenheilk.*, Nov., 1913.
[42] F. Deutschmann, *Arch. für Oph.*, Vols. 78, 79, 81.
[43] McIlroy, *Royal Lond. Oph. Hosp. Rep.*, 17, 254.
[44] Domann, *Beitr. z. Augenheilk.*, Heft 82.

served in Mueller's fluid which makes it difficult or impossible to make out the plasma cells.

Blood changes in sympathetic ophthalmia. In July, 1910, Ormond [45] reported that Dr. Pryce Jones * (the name really being Cecil Price-Jones) had found a "mononucleosis" in three cases of sympathetic ophthalmia. By mononuclears he evidently means large-celled monos; since in his tables he gives the lymphocytes, also showing a marked increase, in a separate column. This condition suggested to these authors that sympathetic ophthalmia was probably a protozoal rather than a bacterial disease. In August of the same year Gradle [46] noted the presence of lymphocytosis in several cases of traumatic inflammation of the sort likely to cause sympathetic ophthalmia, in one of which the enucleated eye, without having caused sympathetic ophthalmia, showed characteristic changes. He also noted its absence in a number of other cases in which ocular wounds healed promptly. In 1911, C. P. Jones and Browning [47] refer to the article of Ormonde [*sic*] as reporting increase of the large mononuclears; and from nine cases of sympathetic ophthalmia (including Ormond's three) they found an average increase of 170 per cent.; with an average increase of 30 per cent. in the lymphocytes. They also report favorable results from the use of salvarsan; thus confirming the idea that sympathetic ophthalmia is protozoal in origin. In a later paper Gradle,[48] pointing out that the line between lymphocytes and large mononuclears is hard to draw, insists on the importance of "mononucleosis" as a diagnostic sign and a therapeutic guide in sympathetic ophthalmia.

Other men who have made blood counts in sympathetic ophthalmia practically all agree that mononucleosis is nearly always present (Sattler,[49] Purtscher and Koller,[50] Brownlie [51]), but some (Hudson,[52] Zentmayer,[53] Collins [54]) have found cases of sympathetic ophthalmia without it and Siegrist [55] has even found a case with diminished leucocytosis. Moreover, others (Gilbert,[56] Franke and Hack,[57] S. R. Gif-

[45] Ormond, *Brit. Med. Jour.*, Oct. 29, 1910, 1326.

* This author's name is printed three ways in one volume of the *British Medical Journal.* From the signature to an original article it apparently is Cecil Price-Jones.

[46] Gradle, *Trans. Heidelberg Oph. Soc.*, 1910.

[47] Jones and Browning, *Brit. Med. Jour.*, June 17, 1911, 1426.

[48] Gradle, *Journ. Oph. and Oto-Lar.*, Feb., 1913.

[49] Sattler, *Trans. Heidelberg Oph. Soc.*, 1912.

[50] Purtscher and Koller, *Arch. für Oph.*, 83, 381.

[51] Brownlie, *Ophthalmoscope*, 13, 307.

[52] Hudson, *Proc. Royal Soc. Med., Oph. Sect.*, 1915, 124.

[53] Zentmayer, *Trans. Coll. Phys.*, Philadelphia, 36, 309.

[54] Collins, *Proc. Royal Soc. Med., Oph. Sect.*, 1913-14, 106.

[55] Siegrist, *Klin. Monatsbl. f. Augenheilk.*, 1913, XVI, 657.

[56] Gilbert, *Arch. für Oph.*, 77, 264.

[57] Franke and Hack, *Arch. für Oph.*, 89, 45.

ford[58]) while admitting its frequency in sympathetic ophthalmia have found it so commonly in other varieties of uveitis, as well as in the other conditions (vernal catarrh, abscess of cornea, normal health) that they deny its value as a therapeutic guide.

On the whole, while it would hardly seem safe to rely upon the blood-count in deciding whether or not to enucleate, the presence or absence of mononucleosis may well be taken into account in doubtful cases.

Pathology of the second eye in sympathetic ophthalmia. Of the small number of microscopic examinations of sympathetic eyes (i. e., second eyes), those which have been published since the particular characters of the sympathogenic inflammation have been established, agree that the inflammation in the second eye is, in all essentials, identical with that which had been found in first eyes. The uveal tract shows the same lymphocytic infiltration with a tendency to be nodal, especially in the choroid; and epithelioid and giant cells occur, as in the first eye. The optic disc and nerve with its sheaths show, perhaps, a more marked infiltration than that commonly found in the first eye.

Diagnosis of sympathetic ophthalmia.

It goes without saying, that in considering the diagnosis of sympathetic ophthalmia, other possible causes of uveitis, especially syphilis, tuberculosis, focal infection and autointoxication, should be taken into account. In doing so, however, it should, naturally, be remembered that the presence of any of these possible causes by no means rules out the probability, in typical cases, that sympathetic ophthalmia is the main or sole cause of the uveitis.

Until we discover a specific germ or an absolutely specific reaction or form of inflammation the diagnosis of sympathetic ophthalmia must remain one of probability. In general, however, in the absence of other etiology, we do not hesitate to class as sympathetic any uveitis which occurs after an interval of two or more weeks, in the presence of a persistent inflammation of the other eye, following a penetrating wound involving the uveal tract. When with the microscope, in such cases, changes of a sympathogenic inflammation are found in the wounded eye, the diagnosis is practically certain. Where such microscopic evidence is not obtained, the author considers the occurrence of the small, roundish, rather sparse choroiditic spots as equally pathognomonic. When neither the microscope nor the ophthalmoscope give much help, the probability of the diagnosis must be based upon the character of the wound and the persistence (not the severity) of the

58 Gifford, S. R., *Arch. of Oph.*, 1918, 327.

subsequent inflammation in both eyes; and to a lesser degree upon the interval of time between the date of the accident and that of the appearance of the inflammation in the second eye. As to the time interval, the majority of the cases of sympathetic ophthalmia develop within four to eight weeks after the injury. Schirmer says that there is no well authenticated case occurring sooner than two weeks after the injury; but while cases in which sympathetic ophthalmia is supposed to have developed sooner than this should be given more than ordinary scrutiny, there is obviously no warrant for drawing the line sharply when we do not know definitely what the most rapid rate of progress to the second eye may be. Since it is certain that some appreciable time must elapse before whatever it is that causes sympathetic ophthalmia can reach the other eye and start an inflammation there; and since it is very rare for the disease to occur sooner than four weeks after the injury, it is natural that cases reported to occur sooner than two weeks should be regarded with suspicion, varying inversely with the length of the interval. While cases called sympathetic ophthalmia have been said to occur as early as the second day, the writer does not know of any case, occurring in less than two weeks, in which the character of the inflammation, the nature of the wound and the microscopic findings all pointed to the diagnosis of sympathetic ophthalmia; but if such a case were to be reported, even within a day or two after the wound, it would have to be given serious consideration.* In default of such an array of evidence it is generally assumed that the diagnosis is wrong, in the phenomenally early cases which occasionally are reported. At the other end of the scale, no time limit has been set; but although cases have been reported with an interval of forty-two years (Weeks [59]), and forty-five years (Knapp [60]), such cases should always be subjected to severe scrutiny, with special stress upon the length of time during which the injured eye has been entirely quiet, and upon the microscopical findings, if these are available.** When an injured eye has been absolutely free from all signs of inflammation for a period, even no longer than several months, there is a good chance that an inflam-

* Since this sentence was written, positive microscopic evidence in the two-day case of Goldenburg, cited in the section on sympathetic ophthalmia after enucleation, has been received.

59 Weeks, *N. Y. Eye and Ear Infirmary Rep.*, 1894, II, 30.

60 Knapp, H., *Arch. für Augenheilk.*, 2, 139.

** Brailey has regularly found signs of active sympathogenic inflammation in old stumps which have caused sympathetic ophthalmia; and Schirmer has found the same, both in stumps with and without bone formation. We are at liberty to interpret this either as a manifestation of persistent germs or of fresh endogenous infection. Either supposition might explain the alleged influence of bone in these stumps. In deciding as to the absolute quiet which apparently has persisted for years in some of these eyes, it should be remembered that extensive active choroiditis frequently persists with no external sign of congestion.

mation appearing in the second eye without any return of inflammation in the first, is a coincidence rather than a consequence. The theoretical possibility of sympathetic ophthalmia after years of quiet in the first eye can be explained either by supposing that the germ of sympathetic ophthalmia may enter into a latent form to be aroused after years by some insult, either external or internal; or by the supposition of a fresh endogenous infection of the injured eye with the sympathetic ophthalmia germ.

Influence of bone formation in sympathetic ophthalmia. So many of the cases in which sympathetic ophthalmia has been recorded, after an interval of several or many years, have been accompanied by the formation of bone in the injured eye that such bone formation has been considered, by many, as one of the exciting causes of sympathetic ophthalmia. Opposed to this is the fact that many cases of bone formation persist for an indefinite length of time without sympathetic ophthalmia occurring. The writer has the impression from three cases of this kind which he has seen, that bone formation may in some cases furnish favorable conditions for the development of the exciting cause of sympathetic ophthalmia. The question, however, needs careful going over with special reference to the presence or absence in the first eye of sympathogenic changes.

Nature of conditions in first eye favoring sympathetic ophthalmia. The accuracy of Mackenzie's conclusion that the cause of sympathetic ophthalmia was, pre-eminently, penetrating wounds exposing the root of the iris or the ciliary body, has been abundantly confirmed by the experience of all succeeding observers. Cuts of the cornea at any point away from the periphery, even with the production of an anterior but non-protruding synechia, or clean penetrations of any other part of the globe which heal promptly without the exposure of uveal tissue, are not at all likely to produce sympathetic ophthalmia. Non-perforating foreign bodies in the conjunctiva, cornea or sclera, are of little account in this connection; and the bad reputation of foreign bodies in the interior chamber of the eye probably depends entirely upon associated infection, or upon the possibility of their constituting foci of secondary infection later on. The fact that comparatively small wounds of the ciliary region are those which we most commonly see associated with sympathetic ophthalmia does not depend upon their smallness, but upon the fact that eyes with small wounds are the ones which we try to save, while the eyes with larger wounds are more apt to be removed at once.

It is evident that some operative wounds furnish ideal conditions for the production of sympathetic ophthalmia; particularly operations for

cataract; and it is not surprising that a number of cases of the disease have been reported after cataract expressions and other operations involving the iris. Whether the determining factor in these cataract cases is merely the inclusion of the iris in the wound (including of course the infection), or whether remaining cortex may contribute to the sympathetic ophthalmia, either by furnishing food for infection or by favoring infection through pressure or chemical influence, is worth considering. The writer has seen one case in which without any iris prolapse, the retention of a very small hard nucleus was followed by the worst case of sympathetic ophthalmia that he has ever seen.

Sympathetic ophthalmia after perforating corneal ulcers, with exposure of the iris, occurs occasionally. It is evident that such cases closely approximate the conditions produced by perforating wounds: the main difference being that in the latter the iris is often lacerated as well as exposed. That sympathetic ophthalmia in all cases of iris prolapse, whether from wounds or ulcers, probably depends upon infection and not upon the dragging upon the iris (as was formerly supposed), is shown by the extremely numerous cases in which such prolapses remain without doing harm for the remainder of a lifetime unless they become irritated.

Although non-penetrating wounds can in general be crossed off as causes of sympathetic ophthalmia, enough cases of *subconjunctival rupture of the sclera,* with or without *luxation of the lens beneath the conjunctiva,* have been reported, to make it seem certain that such wounds may really cause sympathetic ophthalmia. The writer has seen two cases of this sort. To explain such cases on the infective theory, one may assume that the germs have reached the uveal tract through minute abrasions of the conjunctiva; and that this explanation is not far-fetched is abundantly proved by the number of late infections which have been observed after trephining and other sub-conjunctival operations for glaucoma. (The writer has had a verbal report by McReynolds, of one case of sympathetic ophthalmia following such a late infection.)

Aside from wounds as the cause of sympathetic ophthalmia all sorts of conditions such as glaucoma, herpes and cysticercus were in the earlier history of the disease not infrequently reported as etiological factors. But with the growth of the belief in the infective character of sympathetic ophthalmia and with the more critical study of the symptoms and pathology such cases are now generally regarded as apocryphal.

Sympathetic ophthalmia from intraocular tumor is on a somewhat different footing. A number of these cases have been reported, and

while some of them were merely sympathetic irritation; and others were simple papillitis, due perhaps to the carrying over of toxins; and others occurred when the tumor eye had burst; still some eight cases of the thirty collected by Schirmer (p. 54), together with Fuchs'[61] three and Meller's[62] one, may have been true sympathetic ophthalmia, due not to the tumor as such, but to an endogenous infection of the tumor eye, the inflammation spreading from this to the second eye. In all such cases, however, it must be remembered that an equally applicable theory is that both eyes were infected from the same endogenous source.

In numerous cases where one eye has been attacked by an endogenous infection, which later on makes its appearance in the second eye, the question has naturally arisen as to whether or not the inflammation is sympathetic. In this we must answer that we have absolutely no way of proving that it is not. The classical case of Knies[63] and Horner, where a patient, with serous iritis in both eyes, was found on post mortem to have the same signs of inflammation along both optic nerves and their chiasm, increasing in the neighborhood of the globe, is a typical one in this class. There can be no argument over the *possibility* that an endogenous infection may start in one eye and spread to the other by one of the various channels which are open. On the other hand, it is equally undebatable that since the infection has reached the first eye from some point in the general system, it is quite likely to have reached the second eye from the same source.

Relative frequency of sympathetic ophthalmia. The proportion of sympathetic ophthalmia to all eye cases has been given by Mooren as 0.134 per cent. and by Becker as 0.15 per cent. But as Schirmer (p. 38), in citing these statistics points out, it is of much greater importance to know what proportion of penetrating wounds cause sympathetic ophthalmia. Ohlemann[64] found among 556 injuries at the Berlin eye clinic, only two cases of sympathetic ophthalmia; but as a large number of these injuries were of a kind not calculated to produce sympathetic ophthalmia; and of the dangerous eyes nearly all had been enucleated or neurectomized, Ohlemann concluded that in severe penetrating wounds, without efficient prophylaxis, one might expect about 5 per cent. of sympathetic ophthalmia. Schirmer using Ohlemann's material, gives the figure as 2 per cent. but says this is

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[61] Fuchs, *Arch. für Oph.*, 61. 371.
[62] Meller, *Arch. für Oph.*, 72, 170.
[63] Knies, *Arch. für Augenheilk.*, 9, 1.
[64] Ohlemann, *Arch. für Augenheilk*, 22, 112.

doubtless too small; and he cites Knies as giving the probable percentage as 3 per cent.; and Hobby as 3.5 per cent. Szili[65] in recording his experiences with 1092 injuries of all grades, found no case of sympathetic ophthalmia but insists strongly on the value of protecting glasses, and brings out two interesting points; first, that among working men it is chiefly the young ones who do not need glasses at their work who are injured; second, that eye injuries were nearly 40 times as common among "workers" as among "non-workers." Something like this was to be expected and it lines up with the common observation that among non-workers, the most common victims of eye injuries and of sympathetic ophthalmia are *children.*

Foreign bodies and sympathetic ophthalmia. With reference to sympathetic ophthalmia, the presence of an intra-ocular foreign body adds to the danger of a penetrating wound only in so far as it increases the tendency for the traumatic inflammation to continue or to relapse; or as it may act in favoring a subsequent endogenous infection. It will favor sympathetic ophthalmia only if germs accompany or follow via the unclosed wound, or if they settle in its vicinity from the blood. So that if it heals in without reaction, while it may do damage either chemically, mechanically, or possibly by rendering the second eye more vulnerable through reflex irritation, its presence does not make enucleation imperative; although the patient should be warned that it involves a certain amount of extra risk through the possibility of its acting as a center for the development of germs later on. On the other hand, it should be remembered that the removal of a foreign body by no means does away with the danger of sympathetic ophthalmia. Plenty of cases have occurred where sympathetic ophthalmia has developed in spite of a successful removal of the offending substance.

Optic neuritis of the first eye as a premonition of sympathetic ophthalmia. Heerfordt,[66] having seen a case of sympathetic ophthalmia with optic neuritis in both eyes, but farther along in the first eye, concludes that in the rare cases in which the background of the first eye can be examined, neuritis should be watched for as a premonitory sign. The writer has seen one case of this sort with a marked optic neuritis in the first eye only. On account of the early appearance of the papillitis in the second eye, Heerfordt suggests that in this case, and in others, the germ may have passed from the wound in the first eye directly into the blood-stream and thus may have reached the second eye without the intervention of an inflammation in the first

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[65] Szili, *Arch. für Augenheilk.*, 13, 34.
[66] Heerfordt, *Arch. für Oph.*, 69, 559.

one. That is, strictly speaking, the inflammation in the second eye may not have been sympathetic at all; no more so than if the germ had entered the blood-stream from a wound anywhere in the body.

Sympathetic ophthalmia and tuberculosis. The resemblance between the pathological pictures in sympathetic ophthalmia and tuberculosis is so great, that good pathologists have not hesitated, on seeing a sympathetic ophthalmia section, to declare that it must be tuberculosis; and Mackenzie, with characteristic acumen, noted the resemblance between sympathetic ophthalmia and "internal scrofulous ophthalmia." This and the fact that several men, Bernheimer,[67] Stoewer,[68] Norman[69] and others, have seen improvement in sympathetic ophthalmia following injections of tuberculin, has led to the suggestion (Peters[70] et al.) that sympathetic ophthalmia might be a low grade tuberculosis. Ohlemann[71] also calls attention to the fact that the 5 per cent. of sympathetic ophthalmia which his statistics have led him to expect in pēnetrating injuries without enucleation, corresponds to the proportion of latent cases of tuberculosis. It is quite possible that some cases of tuberculous iritis have been taken for sympathetic ophthalmia; but the theory of their identity is refuted by the negative results of repeated attempts to find the tubercle bacillus in sympathogenic eyes, both by the microscope and by animal injections.

Influence of nasal conditions on sympathetic ophthalmia. Ziem[72] who, in 1893, had laid stress on the influence of the nasal cavities in eye diseases, reported several cases of sympathetic irritation which were cured by intra-nasal treatment; and Eversbusch[73] has noted that sympathetic ophthalmia is apt to get worse with attacks of nasal congestion; and to improve on removal of turbinate hypertrophy.

Prognosis of sympathetic ophthalmia. Although it was recognized that sympathetic ophthalmia occasionally appeared as a rather mild serous iritis, the prognosis up to the beginning of this century was considered to be extremely bad. Eyes which recovered with good sight were so rare that they were thought worth reporting. Mackenzie says that he has never seen but one case recover. But under the influence of modern forms of treatment, together with the earlier recognition of the disease, the prognosis became much more favorable. In 1910, the writer[74] out of sixteen cases of sympathetic ophthalmia

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67 Bernheimer, *Arch. für Augenheilk.*, 70, 331.
68 Stoewer, *Arch. für Augenheilk.*, 73, 155.
69 Norman, *Ophthalmoscope*, Apr., 1915, 179.
70 Peters, *Zeit. für Augenheilk.*, 3, 385.
71 Ohlemann, *Arch. für Augenheilk.*, 71, 64.
72 Ziem, *Med. Klinik*, 1908, I, 662.
73 Eversbusch, Graefe-Saemisch 2nd Ed., Th. 2, Bd. 9, Kap. 16, 65.
74 Gifford, H., *Ophthalmoscope*, 1910, 257.

treated with enucleation, large doses of salicylates and mercurial inunctions, was able to report only two bad, one medium, one good and twelve very good results (6/9—6/6.) More recently, Morax[75] in a series of thirty-nine cases collected during the late war, found fourteen bad and twenty-five favorable results. He attributes this good showing to the very general use of neosalvarsan by the French surgeons. On the whole, it seems fair to say that 75 per cent. of the cases, if seen within the first week, can retain useful sight if properly treated. In cases which have run a longer time without treatment, the danger of a bad result in spite of all treatment, is much greater.

Treatment of sympathetic ophthalmia. The *prophylaxis* of the disease should begin with the endeavor to prevent penetrating wounds of the eye. Aside from counsel to the general public to keep sharp implements and toys out of the hands of children, the main effort in this line should be to encourage the use of protective glasses in all dangerous trades.

Next to the prevention of penetrating wounds, comes their proper treatment by cauterization with trichloracetic or carbolic acid; the careful and complete excision of iris prolapses; and the protection of the wound by a sliding conjunctival flap.

Where, after a penetrating wound, an eye which is worth saving develops an obstinate, though not necessarily severe, inflammation, in other words, where it gets into the condition which most frequently leads to sympathetic ophthalmia it is only logical to adopt the treatment (to be outlined later) which has been found most effective in combatting sympathetic ophthalmia itself.

Treatment of iris prolapse, with reference to sympathetic ophthalmia. While many cases of iris prolapse, if let alone, remain unirritated and harmless for the rest of the patient's life, there can be no question that they constitute points of least resistance, liable to infection upon slight provocation. It is highly probable that the safest plan would be to treat all such prolapses by covering them with a sliding conjunctival flap. Even this does not positively ensure against sympathetic ophthalmia. The author had one case in which sympathetic ophthalmia followed such a sliding flap operation, done twenty-four hours after the accident. Morax has recently reported a similar case where the prolapse was cauterized and immediately covered with a sliding flap.

Treatment of iris prolapse with the actual cautery without immediately consecutive protection by a sliding flap is especially to be warned against. This danger was first insisted upon by Trousseau:[76]

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[75] Morax, *Ann. d'Oculist.*, 154, 705.
[76] Trousseau, *Arch. d'Oph.*, 1909, 684.

and the experience of the writer has compelled him to strongly advocate Trousseau's view.

The use of other cauterizing agents, without subsequent conjunctival covering is also to be deprecated. One case of sympathetic ophthalmia following this form of treatment with trichloracetic acid has been noted by the writer. Probably the best method, where it is decided that a prolapse should be treated, is to excise as much as possible with a clean scissors snip, and if enough raw surface can be obtained between the prolapse and the cornea to ensure the adhesion of the protective flap, to slide the latter over without using any form of cauterization; but if, as is generally the case, the prolapse is quite close to the corneal margin, it is best to cauterize a strip of limbus and cornea at least 2 mm. wide and three times as long as the prolapse before sliding over the flap. For this purpose trichloracetic acid is perhaps the best agent; if the electric cautery is used the eschar should be carefully scraped off. If the prolapse is not prominent enough to permit it to be easily fixed with the forceps or sharp hook, it is probably better merely to prick it after touching the surface lightly with trichloracetic, before drawing over the flap. When a *sub-conjunctival* prolapse is prominent enough to cause anxiety, it can sometimes be flattened out permanently by pricking it with a small knife passed along some distance beneath the conjunctiva, before reaching the iris.

Prophylactic operations in sympathetic ophthalmia.

The history of the operative measures which preceeded the adoption of enucleation has already been given. In Great Britain the principle was early laid down that every blind wounded eye, even if free from irritation, should be enucleated; and while many still adhere to this rule, it is now generally recognized that no matter how badly injured or inflamed a sightless eye may have been, it is not at all likely to cause sympathetic ophthalmia if it has been perfectly quiet for a year or more; so that the removal of such quiet eyes, or the performance upon them of some of the substitutes for enucleation, is by most practitioners rather suggested as desirable, than strongly urged as necessary.

Where there is no reasonable expectation of retaining useful vision, the rule in recent accidents, or in the presence of continued irritation, or of recurrences of such irritation is to recommend enucleation or evisceration. In doing so, however, the practitioner should protect his reputation by a specific and preferably, a written declaration that there is no certainty, if the patient declines the operation, that the second eye will become involved.

Where the injured eye has some reasonable chance for useful sight, and the injury is of the kind which commonly causes sympathetic ophthalmia, *even if the inflammation following it is slight,* the responsibility for the decision as to running the risk of sympathetic ophthalmia in an attempt to save the first eye must, in the last instance, be thrown upon the patient or his relatives. It should be explained that in the presence of continued inflammation the disease rarely, if ever, occurs before the second week; and after that the danger increases up to the eighth week and continues or decreases according to the continuance or diminution of the inflammatory symptoms. The patient should be made to understand that while the chance of the second eye becoming affected is not great, the disease, when it occurs, usually comes on without any premonitory symptoms; and that, once started, it sometimes leads to complete blindness, in spite of all treatment. If after such a statement of the case, preferably in writing, the patient declines to accept the responsibility and insists that the surgeon make the decision, the latter must put himself in the patient's place and tell him what he *believes* he would do or want done if he were in a similar position.

Sympathetic ophthalmia after enucleation and evisceration. The security afforded by the various preventive operations is only relative: sympathetic ophthalmia has been observed after all of them. On the germ theory this was to be expected after optico-ciliary neurotomy and neurectomy, but that at least 45* cases of this sort should have been seen after enucleation, calls for the supposition that at the time of the operation enough germs had already passed out of the injured eye to successfully combat the resistance of the body and to reach the second eye by way of the lymph channels or the blood vessels.

The time interval between the enucleation and the outbreak of sympathetic ophthalmia has been reported as varying from twenty-four hours, (Steinheim [78]) to twenty-one years, (Ferdinands [79]). The cases included between that of Steinheim and Stephenson's fifty-four day case [80] form a series with a fairly uniform gradient, so that we accept them without much hesitation. Then come the cases of Poulard,[81] Bickerton,[82] Weiss,[83] and Westermann,[84] with intervals of three

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* Jampolsky calls it 65; but her list, apparently, includes repetitions. A later summary by Schieck (abst. in *British Journ. of Oph.*, Oct., 1919, 463) gives 80 cases of sympathetic ophthalmia after enucleation.

78 Steinheim, *Arch. für Augenheilk.*, 9, 47.

79 Ferdinands, *Brit. Med. Jour.*, 1898, 1583.

80 Stephenson, *Trans. Oph. Soc. U. K.*, 37.

81 Poulard, *Ann. d'Oculist.*, 154, 702.

82 Bickerton, *Oph. Review*, 1898, 247.

83 Weiss, cited by Ferdinands.

84 Westermann, *Rev. gen. clin. et. therap.*, 1908, 280.

months and twenty-one days, (Poulard calls it four months), 127 days, two and a half years and eight years, respectively. Finally, come those of Ferdinands, with intervals of fourteen years and twenty-one years. While these very late cases are probably mere coincidences, we have no grounds for setting a time limit for this unfortunate complex; and if a case were to furnish a characteristic clinical history for each eye with characteristic pathology in the enucleated one, the diagnosis of sympathetic ophthalmia would have to receive serious consideration, without regard to the time interval. And if it be asked where the supposed germ may have rested during this period we ought to take into account not merely the orbital tissue, optic nerves, chiasms and their sheaths, together with the capillary walls in general; but we should entertain the possibility that the germ may have reached the second eye and become dormant there, to be aroused into activity by some subsequent irritation.

Of importance from another point of view, is the interval between the date of the wound and that of the operation. The best evidence as to the shortest time required for the cause of sympathetic ophthalmia to get outside of the first eye is given by the case of Fuchs,[85] in which somewhat characteristic changes were found in an eye (from a case without sympathetic ophthalmia) enucleated five days after the injury. Where, as in Goldenburg's [86] case, the eye was enucleated 24 to 48 hours after the injury it would seem necessary to furnish strong evidence from the enucleated eye to warrant the diagnosis of sympathetic ophthalmia.*

The general impression is that these cases are apt to run a light course; but this rule is by no means invariable. Jampolsky [87] has reported a severe course in half of her series of eight cases. The severity of the course seems to bear no constant relation either to the time interval between the injury and the enucleation, or that between the enucleation and the outbreak of the disease.

The cases above referred to do not include those of the astonishing report of Morax *(loc. cit.)* who in a series of 39 cases observed by French surgeons in the late war, found 11 cases in which the disease

[85] Fuchs. *Arch. für Oph.*. 70. 482.

[86] Goldenburg. *Am. J. Oph.*, Sept., 1918, 680.

* Since this was written the writer has been enabled, through the kind coöperation of Dr. Goldenburg and of Dr. Francis Lane. to see slides from this eye. The uveal tract was found to be the seat of an infiltration which was almost exclusively mononuclear; i. e. it strongly suggested the incipient stage of a sympathogenic inflammation. Dr. E. V. L. Brown also concurred in this view. The inflammation appeared in the second eye 16-18 days after the enucleation. Subsequent information shows that this case of Goldenburg's was reported incorrectly and has no significance in this connection, as the enucleation was not performed for some time *after* the inflammation had broken out in the second eye.

broke out after enucleation; and two in which it occurred after evisceration. This appalling record is so at variance with all previous experience on the subject that it is impossible not to regard it with great suspicion.

For the literature on this subject see Welton (*Arch. of Ophthal.*, 40,378), Jampolsky *(loc. cit.)* and Schieck *(loc. cit.)*.

With regard to the occurrence of *sympathetic ophthalmia after evisceration,* the report of the English committee on the subject (*Trans. Oph. Soc. of the United Kingdom,* XVIII) stated that the evidence did not indicate that evisceration or Mules' operation was any more likely to be followed by sympathetic ophthalmia than was enucleation. For the cases that occur within a few weeks after the operation there is probably no need of taking exception to this decision, but from the statistics available to the writer [87] (*Oph. Record,* Nov. 1908), it seemed probable that ordinary evisceration was somewhat more dangerous than enucleation and that Mules' operation was more dangerous than ordinary evisceration. At that time, 15 cases of sympathetic ophthalmia after Mules' operation were reported, and 9 cases after ordinary evisceration; but as no attempt had been made to find out how many of the different sorts of operations had been performed, the conclusions merely represent the attempt at a shrewd guess. But the fact that evisceration leaves a part of the eye connected with the optic nerve certainly indicates the possibility of a greater risk than after enucleation.

To meet this objection Huizinga [88] has combined evisceration with the excision, through the scleral opening, of the optic disc and a piece of the optic nerve; but even this does not remove the objection entirely, since there remain the vessels perforating the sclera around which, in sympathogenic eyes, the characteristic infiltration is frequently found; and slight remains of uveal tissues have frequently been found in evisceration stumps. The writer believes that the weight of such objections is so slight that for eyes without traumatic inflammation they do not equal the cosmetic advantages afforded by a properly performed evisceration, as compared with simple enucleation. For traumatically inflamed eyes, on the other hand, enucleation is to be preferred; and whether or not it should be done with the introduction of some substance into Tenon's capsule, may be debatable. Sympathetic ophthalmia has followed such operations also, and until convincing statistics can be produced, a decision must be made on theoretical grounds; and as the introduction of any foreign substance into Tenon's capsule or into an evisceration cavity, might be supposed to favor the production

[87] Gifford H., *Oph. Rec.*, 1908, Nov.
[88] Huizinga, *Journ. Am. Med. Ass'n*, Feb. 17, 1900.

of sympathetic ophthalmia, the auto-graft of fat should be preferred, if time and further experience show that the advantage obtained by it is permanent.

Since certainty as to the relative value of the different prophylactic operations is not attainable and the slight theoretical advantage of simple enucleation over all competitors can not be denied, it seems to the writer that the patient or his relatives should have the chance of deciding whether he prefers one of the slightly more risky operations, for the sake of a somewhat better cosmetic result.*

Substitutes for enucleation. Abscission of the anterior part of the globe and optico-ciliary neurectomy have been so universally discarded that they need no further mention. More can be said for optico-ciliary neurectomy, for although in some of the lower animals, the writer has shown (*Trans. Int. Med. Cong.*, Washington, 1887) that in such neurectomized eyes, pigment particles are carried out along the central vessels of the optic nerve into the orbit near the central end of the nerve, it has not been shown that sympathetic ophthalmia occurs more frequently after this operation than after enucleation. Still the theoretical objections are so great, that the operation should, it is believed, be used only for blind but not inflamed eyes, or where enucleation or evisceration is refused. When it is performed, the ocular end of the nerve should be cauterized, as suggested by Wagenmann in 1895.[89]

Evisceration (Noyes); Extenteration (Graefe). Properly performed, simple evisceration undoubtedly gives a better stump than simple enucleation. It is more easily done, and, especially in suppurating eyes, it is probably less likely to cause death from meningitis.†

* It sometimes becomes necessary to remove the *second* eye and leave the first. This was done by Herczogh (*Zeitschr. f. Augenheilk.*, p. 20, Sept. 1908) for a blind second eye that continued painful and irritable. The first eye eventually recovered V.= 6/10. Bird also has raised the question of the justifiability of sacrificing the second eye for the benefit of the first. *Practical Med. Series. Eye*, p. 138, 1913.)

89 Wagenmann, *Arch. für Oph.*, 41, 1.

† Death after enucleation is one of the possibilities. In 1885 Deutschmann and Brückner (*Archiv. f. Augenheilk.*, 31, 4, 251), collected 24 cases of this sort and several have been reported since then. In the great majority, the eye removed was suffering from panophthalmitis, or at least an active infection. The occurrence of such cases suggested to Alfred Graefe the desirability of doing exenteration in all cases of panophthalmitis. In the 1st Edition of Czermak's work on ophthalmic operations, report was made of two cases of death after evisceration, but the 2nd edition explained that in these cases (of Schulek's) the operation was evisceration of the orbit. Since then, Simpson (*Jour. Oph. and Oto-Lar.*, 1916, 157), Ellett (*ibid*) and Clegg (*Oph. Rev.*, Aug. 1914), have each reported a death after evisceration of the eye. It should also be remembered that Warlomont, at the Heidelberg Congress in 1863, reported a death from meningitis after discission of the lens; and that Webster (*Archiv. f. Augenheilk.*, Vol. 21, p. 191) had a death from panophthalmitis following a cataract extraction; without enucleation having been performed in either case.

On the other hand, it is followed by more pain and reaction and on this account, as well as on account of the greater danger of its being followed by sloughing of the sclera in advanced years, it is not to be recommended for the aged. Theoretically, it is not quite so likely as enucleation to protect against sympathetic ophthalmia and in the form of Mules' operation it gives a better cosmetic result with probably a slightly greater risk. For perfectly quiet stumps, where the operation is done not on account of danger of sympathetic ophthalmia, but for the cosmetic result, the writer believes that the cosmetic advantage of evisceration outweighs the extra risk. For injured eyes. with the sort of inflammation which we consider most likely to cause sympathetic ophthalmia, enucleation is probably safer. (See paragraph on sympathetic ophthalmia after enucleation.)

Relation of panophthalmitis to sympathetic ophthalmia. The idea that panophthalmitic eyes or stumps are not likely to cause sympathetic ophthalmia dates back at least to Wardrop, who adopted the idea from the farriers; and although the infrequency with which present day ophthalmologists see sympathetic ophthalmia following panophthalmitis is easily explained by the fact that such eyes are now promptly removed or eviscerated, such an explanation does not apply to the years before about 1880, during which it was the custom, with the majority of continental oculists, to leave such eyes in the head, treating them by free incision and hot applications. Not only this, but up to the early sixties, many wounded, non-suppurating eyes which we now enucleate as dangerous, were treated by various methods calculated to produce suppuration. So that although the protection afforded by panophthalmitis is by no means absolute, as was especially urged by Alt, it is marked enough to call for some attempt to explain it. Leber and Deutschmann believed that it was due to a destruction of the germs by the violence of the inflammation. The writer suggested that it might result from the blocking of the lymph channels by leucocytes; while Schirmer undoubtedly came nearer to the mark in his belief that sympathetic ophthalmia is probably caused by some germ entirely different from the pus-germs which cause panophthalmitis; and that the rare cases when sympathetic ophthalmia has followed panophthalmitis can be explained by a combination of the pus-germs with those of sympathetic ophthalmia. Evidence for the truth of this supposition was furnished by Schirmer's examination (p. 113) of two panophthalmitic eyes which had been removed on account of sympathetic ophthalmia of the fellow eyes. They both showed that the suppurative process had been incomplete and that in the posterior part, the remaining choroid had the foci of lymphocytic infiltration

which are commonly found in sympathetic ophthalmia. Schirmer concludes that in most cases of panophthalmitis, the germ of sympathetic ophthalmia is not present, or that if originally present, in a mixed infection, it generally is overgrown and destroyed by the pus-germs. This, it will be seen, recognizes to some extent the theory of Leber and Deutschmann, and by no means excludes the probability that the blocking of the posterior lymph channels of the globe may also play a part in the relative immunity from sympathetic ophthalmia which panophthalmitis probably confers.

Treatment after sympathetic ophthalmia has appeared. If the exciting eye is blind or so badly injured that under the best of circumstances useful vision can hardly be expected, enucleation should be done as soon as possible. The fact that the first eye has been known to recover with better sight than the second has led some (e. g., Schirmer) to lay down the rule that the first eye should not be enucleated as long as it has any light perception. The writer considers this altogether too conservative. Sympathetic ophthalmia is dangerous enough at the best, and while the immediate effects of enucleation in real sympathetic ophthalmia are in most cases not striking, occasionally they are so; and theoretical considerations strongly indicate the advisability of removing the original focus, which if left, must continue to feed the flame on the other side; and this view is supported by the results of statistical investigation made by the Ophthalmological Society of the United Kingdom.[90] Where the exciting eye still has useful vision, or good prospect for such, or where the condition of both eyes is so bad that there is little choice between them, the common rule is to avoid enucleation unless the prospects of the exciting eye continue to get relatively worse.

Like every other obstinate disease sympathetic ophthalmia has had a large number of measures recommended for its cure, although the number has been kept down by the discouraging fact that so few have apparently done good. Let us consider only those which have stood the test of experience or which, on theoretical grounds, offer great promise. Atropine should be used to the limit if necessary to produce full dilation; a greater effect being obtained if it is used with a little cocain and adrenalin. Hot applications are generally recommended and would seem rational if the disease were confined to the anterior part of the eye; but one must confess that, while having strong faith in their usefulness in ordinary iritis, there is the impression that in sympathetic ophthalmia they are less effective and sometimes

[90] *Trans. Oph. Soc. United Kingd.*, 18, 233.

even are of worse than negative value; this possibly because the disease reaches farther back than the heat can penetrate. In the way of internal treatment, *salicylic acid* and its derivatives, with *atophan* as an alternate, hold the most important place. The writer generally uses the salicylate of sodium, but considers that it makes little difference whether this or aspirin, displosal, benzosalin or something else of a similar nature is used, the important thing being the size of the dose. For each pound of body weight a grain in twenty-four hours may be considered a normal dose (of benzosalin, recommended by Stock, use twice as much) ; the fractions being scattered throughout the day, preferably with the addition of a little alcohol in the form of brandy or whiskey; but where this can not be obtained a little nitroglycerine may possibly take its place. In rebellious cases, it is justifiable to use a considerably larger dose; 200 to 300 grains a day may be given to a 150 pound individual with the addition of an equal amount of bicarbonate of sodium to guard against acidosis. While under this treatment, the patient should stay in bed practically all the time; especially toward the end of the day, and should have the head covered with a dry towel to guard against catching cold. Where there is any tendency to disturbance of the stomach, each dose should be given in a large glassful of hot water sipped slowly. The addition of the essence of pepsin seems to help in some cases, but if the stomach continues to give trouble a large part of the daily dose can be given by the rectum; a sixty grain dose in a glassful of warm water, two to three times a day. It may be worth while, in an occasional case, to use the salicylates by intra-venous injection, though the writer has had no experience with this. It must be insisted that the occurrence of tinnitus, a moderate amount of deafness and profuse sweating are not contra-indications. With delirium the case is different, as this occasionally occurs in so severe a form as to make a change necessary. Here is where *atophan* comes in.* In the same dose, it has fully as much effect upon the inflammation as the salicylates, without producing the sweating, ear symptoms or delirium, although it has as much or an even stronger tendency to disturb the stomach. The main reason for not employing it as a rule, instead of the salicylates, is its high price. With the salicylic compounds and atophan it is of course neither essential nor desirable to continue with the maximum dose if it is found that a smaller dose will control the inflammation; but since

* The systematic use in sympathetic ophthalmia, of salicylate of sodium in large doses was first recommended by the writer in 1899 (*Jour. Am. Med. Assocn.*, Feb. 10, 1900); also independently, by Heuse (*Centrlbl. pkt. Augenheilk.*, Apr. 1901). See also *Ophthalmic Record*, Dec. 1902; and *Ophthalmoscope*, 1910, 257. For the use of atophan in special cases, see *Ophthalmic Record*, 1914, p. 349.

there is no way of knowing at the beginning of the case whether it will be a light or a severe one, and every day of insufficient treatment counts against the patient, it is considered that the safest plan is to give a three-fourths dose the first day and if this is well borne, a full dose on the second day. When the inflammation seems to be controlled, the full dose need be given on only three or four days in the week, a half dose being given on the other days. When the eye has remained free from inflammation for three weeks it is generally sufficient to give a three-fourths dose on only three days in the week; keeping this up for at least three months after the eye seems to be entirely well. This long-continued treatment is not necessary in every case, but it is desirable, in order to be on the safe side.

Patients past the sixtieth year are apt not to bear the salicylates as well as younger patients; with them it is not infrequently desirable to use atophan for part or all of the dose.

In addition to the salicylate or atophan treatment, inunctions of mercury (a piece of the ointment the size of the patient's thumb, rubbed in daily for one week out of three until the symptoms are under control) are worth while.

On the ground that sympathetic ophthalmia might be a protozoal disease, the writer has tried *atoxyl* with favorable results in three cases; but the reported danger of optic nerve atrophy from its use seemed so great that it was thought best to discontinue it.

Urotropin, 40-80 grains a day, has been strongly recommended by Dinkelspiel.[91] It would seem to be a rational experiment. Salvarsan or neo-salvarsan was tried by Jones and Browning (*loc. cit.*) because the prevalence of large mononuclear cells in the blood of sympathetic ophthalmia patients suggested a protozoal origin of the disease. They found that it always caused an improvement both in the blood picture and in the eye symptoms, but that recurrences kept coming in spite of it. It has also been recommended by de Ridder, Siegrist, Chaillous, Calhoun and others; although negative results have not been wanting. More recently Morax (*loc. cit.*) is inclined to attribute the unusually favorable results in his series of war cases of sympathetic ophthalmia to the prevalent use of novarsenobenzol (neo-salvarsan) by the French surgeons.

So far as the writer knows, Zur Nedden[92] was the first to suggest and to practise the treatment of sympathetic ophthalmia with the serum of sympathetic ophthalmia patients. Both Derby and Pratt[93]

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[91] Dinkelspiel, *Journ. Oph. and Oto-Lar.*, Nov., 1910.
[92] z. Nedden, *Arch. für Oph.*, 62, 193.
[93] Derby and Pratt, *Arch. of Oph.*, Nov., 1911.

have had good effects, while Brons[94] had negative results with this treatment. Whether the emulsion and serum used in these favorable cases has acted specifically, or by producing non-specific antibodies, such as are produced by any foreign serum, may be questioned. In either event the further use of sympathetic ophthalmia serum may be worth while, when it is available.*

Dimmer[95] and Ahlström[96] have reported cases of sympathetic ophthalmia where intercurrent angina has seemed to cause a marked improvement in the disease. This reminds one of the occasional reports of improvement in other eye troubles which has followed attacks of erysipelas, and of a case reported by Harlan,[97] of a cure of interstitial keratitis by intercurrent measles. In the attempt to follow this hint of nature, it may not seem best to inoculate our sympathetic ophthalmia patients with some infection; but we might try some of the stock bacterial emulsions. In this line the author has tried phylacogen in two cases of sympathetic ophthalmia with considerable, but not phenomenal, improvement of the symptoms; and Ziegler[98] has also tried it in old iritis with some success, while Crockett[99] has treated sympathetic ophthalmia successfully with a staphylococcus vaccine.

Tuberculin has, in a few cases of sympathetic ophthalmia been tried with good results (Bernheimer, Stoewer, Norman) and while some of these cases may have actually been tuberculosis, it may well be that the germ of sympathetic ophthalmia, whose pathological products so closely resemble those of the tubercle bacillus, may also be sensitive to tuberculin.

Sub-conjunctival or (more rarely) intraocular injections of sublimate or cyanide of mercury, which undoubtedly are of use in primary traumatic inflammation, may well be of use in sympathetic ophthalmia; but they blur the picture and make it hard to control the effect of more important treatment. This objection does not apply to simi-

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94 Brons *Münch. Med. Woch.*, 1906, 1938.

* It should be noted that Dor in 1897 (*Ann. d'Oculist.* 117, 366) had reported good results from injections of an emulsion of uveal tissue from eyes enucleated for sympathetic ophthalmia. Further as bearing on the presense of specific antibodies in sympathetic ophthalmia patients, Hegner (*Münch. Med. Woch.* 1913, 21) using the Abderhalden method. found evidence of uveal destruction in the blood of patients with uveal wounds and especially in sympathetic ophthalmia: v. Hippel also (*Berichtder Ophthalm. Gesell.* p. 26, 1913) found a positive Abderhalden in three out of eight cases of sympathetic ophthalmia. Frenkel and Nicolas (*Ophthalmoscope*, p. 250. May, 1915) have obtained negative Abderhalden results in a number of cases of irido-cyclitis.

Kümmell (*Archiv f. Augenheilk.*, 84, 440) has found a positive serum reaction for uveal products, in three out of ten cases of sympathetic ophthalmia.

95 Dimmer, *Zeit. für Augenheilk.*, 130, 455.

96 Ahlström, *Centralbl. f. prakt. Augenheilk.*, 1904, 199.

97 Harlan, *Arch. of Oph.*, 30, 9.

98 Ziegler, *Am. J. Oph.*, Mch., 1918, 57.

99 Crockett, *Arch. of Oph.*, 1914, 378.

lar injections into the orbit or stump of the enucleated eye; a practice quite in favor with some French oculists. Abadie [100] reports one case where injection of 1-1000 failed, but where five to six drops of sublimate 1-100 into the stump had a prompt and lasting effect. Subconjunctival injections of iodide of sodium 1-2000 have been strongly recommended by Weigelin.[101].

The writer feels that while, for the present at least, the safest plan of treatment is to depend on the salicylate compounds or atophan, with inunctions of mercury, as the backbone of the system, these other remedies should be kept in mind to be tried if the salicylates fail, or in addition to the latter in unusually bad cases.

It goes without saying that the bowels should be attended to and the writer believes that from the start, liberal doses of mineral oil or, preferably, Chesebrough's yellow vaseline should be given, with the addition of some laxative if necessary, to produce free soft movements. This should be kept up till the cure is complete.

It has recently been advised to defer treatment till the various tests can be made to determine, as nearly as possible, just what things the patient has which might influence the disease. This is most pernicious doctrine. While a thorough examination is highly desirable, vigorous treatment with the remedies which are known to be effective, should be started at once. If the injured eye is to be removed, don't put it off till the next day. Do it promptly at the office, if an immediate trip to the hospital is inconvenient. The danger of a bad result increases directly with the length of time during which the disease goes unchecked. A single day's delay may make the difference between sight and blindness.

Operations on eyes affected by sympathetic ophthalmia. When in any case the active symptoms of sympathetic ophthalmia have subsided, leaving the eye with much reduced vision, on account of blocking of the pupil or opacity of the lens, there is a great temptation to operate too soon. The great danger of thus lighting up the old inflammation and spoiling all chance for improvement, can not be too strongly insisted upon. One should wait at least a year after all signs of congestion have disappeared, before attempting even so slight an operation as an iris puncture. Even when the tension is too high, it is best to defer interference much longer than in ordinary cases. Such eyes seem to be unusually tolerant of a moderate increase of tension. When such an eye is operated upon, the surgeon should not be too sanguine either in his expectations or his prognosis. When an iridectomy is done the pigment layer of the iris is apt to remain attached

[100] Abadie, *Ann. d'Oculist.*, 139, 409.
[101] Weigelin, *Klin. Monatsbl. f. Augenheilk.*, 52, 141.

to the lens, so that it becomes necessary to remove or cut through the latter even without knowing just what condition it is in; and after this has been done, repeated iridocapsulotomies are often necessary to give the patient what chance for improvement there is.

The influence of focal infections and auto-intoxication on sympathetic ophthalmia. From the prominent part which focal infections have assumed in a great variety of bodily afflictions, it is not surprising that the possibility of their being in some way connected with sympathetic ophthalmia should have been considered. No one, so far as known, has claimed that the germs ordinarily concerned in focal infections are the cause of sympathetic ophthalmia, but it is not improbable that the ordinary focal-infection germs, or their toxins, might prepare the tissues of the eye for an invasion by the sympathetic ophthalmia germ; or might contribute to the virulence of its action; or to recurrences in the subsequent course of the disease. It follows that if this connection is to be given any weight in sympathetic ophthalmia therapeutics, focal infections should be carefully looked for and eliminated; in cases of penetrating wounds, *both before and after* the development of sympathetic ophthalmia. A practical application of this idea has been made by E. V. L. Brown [102] who has reported improvement in sympathetic ophthalmia following the removal of infected tonsils; and the writer has also been led to pay careful attention to focal infections in the prophylaxis and in the treatment of the disease both in connection with accidental and with operative wounds.

In the same rank with focal infections one should put intestinal and other forms of auto-intoxication. Panas [103] laid stress on auto-intoxication as a possible factor in sympathetic ophthalmia; and Arnold Knapp [104] has obtained excellent results in four cases of sympathetic ophthalmia by paying special attention to the reaction and the bacterial flora of the contents of the colon, along the lines laid down by Dwyer.[105] As an instance of another form of auto-intoxication of importance in this connection, the cases of malignant uveitis, treated successfully by Bordley [106] with thyroid extract, are worth remembering.

It may be questioned whether Bordley's cases were due to auto-intoxication in the narrower sense, or whether they were cases of auto-infection induced by the lack of resistance to infective processes which, according to the view urged especially by Percy Dunn, is one of the

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[102] E. V. L. Brown, *Oph. Rec.*, 1917, 313.
[103] Panas, *Traite des mal. d. Yeux*, II, 376.
[104] Knapp, Arnold, *Trans. Oph. Sec. A. M. A.*, 1919.
[105] Dwyer, *Journ. Am. Med. Ass'n*, Dec. 21, 1918.
[106] Bordley, *Journ. Am. Med. Ass'n*, Aug. 5, 1916.

effects of a deficient thyroid secretion. In either event, the resemblance of these cases to sympathetic ophthalmia suggests the advisability of trying thyroid extract in rebellious cases.

Whitening of the lashes in sympathetic ophthalmia. Several cases of whitening of the lashes have been reported in patients with sympathetic ophthalmia. In one of these (Jacobi[107]) the lashes on the side of the injured eye, which had been enucleated, retained their color while those on the other side turned partly or wholly white several months later. Cramer,[108] who has seen one of these cases in which the hair of the pubis and axillæ also were whitened, believes that the phenomenon should be interpreted as a manifestation of anaphylaxis from disintegration of uveal pigment and hence should be considered evidence for the anaphylactic theory of sympathetic ophthalmia. To the writer, it seems impossible that an exhibition of anaphylaxis which must depend on the distribution of pigment antigen throughout the entire system could be localized in the lashes of one or both eyes. It would seem more probable that the localized disturbance in the circulation or in the nerve impulses was the cause of the whitening. When, as in Cramer's case, other parts of the body are affected, the hypothesis of a general toxemia would seem to offer a more reasonable explanation than that of an uveal anaphylactic attack; especially since the pigment of the eyes has never been blanched in these or any other cases of sympathetic ophthalmia. The fact is that the etiology of hair whitening is a very obscure corner, as may be gathered from any good work on dermatology. Beside the doubt as to how much the whiteness depends on lack of pigment and how much on the presence of air in the shaft, there is some evidence that when pigment is absent in the shaft, this depends, not on a deficiency of pigment-production but on a disturbance of the cells which normally convey it to the shaft.

Evidences of meningitis in sympathetic ophthalmia. The theory that sympathetic ophthalmia proceeds by the optic nerve route requires an explanation of the non-occurrence of meningitis. It is commonly assumed that the sympathetic ophthalmia germ has no especial fondness for growing in the cranial cavity; but that either the germ or its toxins get there is indicated by the rather severe headache which occasionally precedes an outbreak of sympathetic ophthalmia. Haab has laid much stress on this; and urges that in doubtful cases, severe headache ought to turn the scale in favor of enucleation. The writer has seen cases of this kind. More striking evidence of a meningitis is furnished by the cases of *deafness* occurring in the course of sympa-

[107] Jacobi, *Klin. Monatsbl. f. Augenheilk.*, 1874, 153.
[108] Cramer, *Klin. Monatsbl. f. Augenheilk.*, 51, II, 205.

thetic ophthalmia. Seven cases of this kind have been collected by Peters,[109] who regards the phenomenon as an anaphylactic one due to sensitization of the labyrinthine pigment. This explanation seems badly forced. If sympathetic ophthalmia were an anaphylactic disease and the labyrinthine pigment were akin to that of the uvea, deafness ought to be a common complication instead of one of the rarest. In view of the fact that several of these patients suffered from headache and delirium, a slight meningitis seems a much more likely cause. In this connection the suggestion of Domann that in the search for evidence of meningitis, a lumbar puncture should be regularly made in sympathetic ophthalmia is well worth trying out.

Etiology of sympathetic ophthalmia.

In 1741, Le Dran *(loc. cit.)* offered the first suggestion as to the method of transference in sympathetic ophthalmia, when he recommended a wide opening in badly inflamed eyes, "since if one should wait, as in the case of other abscesses, for the formation of pus, the patient might lose his sight by the inflammation which is communicated to the other eye by way of the optic nerve." Mackenzie, as already noted, while admitting as possible the influence, in the production of the disease, of the vessels or the ciliary nerves, believed that "the chief medium through which sympathetic ophthalmia is excited is the union of the optic nerves." In the latter part of the fifties, under the prevalent notion that reflex action could stir up genuine inflammation, the ciliary nerve theory was advocated by Arlt, *(loc. cit.)* and especially by Heinrich Müller;[110] and for twenty years, this theory practically held the boards. In 1877, Alt,[111] on discovering that a large number of sympathogenic eyes showed signs of inflammation in the optic nerve stump, suggested that beside extending by the influence of the ciliary nerves, the inflammation might reach the second eye through the optic nerve and chiasm. In 1879, Knies *(loc. cit.)* and MacGillavry[112] offered pathologic evidence of transmission by the optic nerve route. By 1880, the germ theory of inflammation was adopted so generally that it naturally was applied to sympathetic ophthalmia; and in this year, Berlin[113] advanced the theory that the disease was due to germs which entered the general circulation from the first eye, and which produced inflammation in the second eye, but not

[109] Peters, *Klin. Monatsbl. f. Augenheilk.*, 50, II, 433.
[110] Müller, H., *Arch. für Oph.*, 4, 2, 368.
[111] Alt, *Arch. für Augenheilk.*, 6, 210.
[112] MacGillavry, *Trans. Cong. Internat. d. Sc. Med.*, Amsterdam, 1879, p. LXI.
[113] Berlin, Volkmann's *Klinische Vorträge*, Nr. 186, 1537.

in other parts of the body, because the eye alone offered the conditions (perhaps narrowness of choroidal vessels or access to light) necessary for their development.

Opposed to Berlin was the theory proposed in 1881 by both Leber [114] and Snellen [115]. They held that sympathetic ophthalmia must be a germ disease, but that the microbes spread from the first eye to the other, by way of the optic nerves or their sheaths and the chiasma. The first to attempt to produce sympathetic ophthalmia in animals, seems to have been Maats,[116] who, in the sixties, obtained only negative results from numerous injuries to the ciliary region of rabbits, with knives and other foreign bodies. Soon after the appearance of Snellen's and Leber's articles, however, Deutschmann [117] reported that out of a large number of experiments in which he injected pus-cocci into the vitreous of rabbits, the second eye showed signs of papillitis in a large proportion of the cases, the cocci, with signs of inflammation, could be traced to the second eye along the intravaginal space and the optic nerves and the chiasm. No irido-cyclitis was produced in the second eye, but as the animals all died of general infection soon after the papillitis occurred, Deutschmann assumed that the anterior part of the eye would have been affected if the animals had lived longer. His experiments were published in a series of elaborate articles and for several years they were accepted as the solution of the problem. In 1886, the writer [118] attempted to confirm these results without success; but as he had previously found that, in several of the lower animals, pigment was regularly carried out of the eye into the orbit along the lymph-spaces surrounding the central retinal-vessels; and as, in a few cases, anthrax bacilli apparently reached the second eye by this path through the orbit, thence through the sphenoidal fissure to the cranial cavity, and thence along the inter-vaginal space to the second eye, he suggested that the germ in man might follow the same route.

Deutschmann's experiments were repeated by a number of other men, in the course of the eighties and early nineties, with negative results (Mazza,[119] Randolph,[120] Limbourg and Levy,[121] Greef [122]

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[114] Leber, *Arch. für Oph.*, 27, 1, 331.

[115] Snellen, *Trans. Internat. Med. Cong.*, Lond. 1881.

[116] Maats cit. by Mooren. *Sympathische Gesichtsstörungen*, 113.

[117] Deutschmann, R. *Arch. für Oph.*, Vols. 28, 29, 30, 31. Ophthalmia migratoria Hamburg, 1889.

[118] Gifford, H., *Arch. of Oph.*, XV, 281.

[119] Mazza, *Trans. Internat. Oph. Cong.*, Heidelberg, 1888.

[120] Randolph, *Arch. f. Augenheilk.*, 21. 159.

[121] Limbourg and Levy, *Arch. f. Exp. Path u. Pharm.*, 28, 153.

[122] Greeff, Heidelberg Supp. 21, *Klin. Monatsbl. f. Augenheilk.*, 1892.

Schirmer[123].) A partial confirmation of Deutschmann's position was given by Basevi[124] and Parisotti,[125] while Gayet,[126] thought that he produced sympathetic ophthalmia in the shape of a keratitis and that the germs passed by the optic nerves and chiasma to the peripheral end of the second intervaginal space, thence along the central vessels to Tenon's space, thence to the corneal margin.*

The numerous failures to confirm Deutschmann's results, while they cast doubt on the nature of the germ and the path taken by it in reaching the second eye, did not for the next twenty-five years produce any serious criticism of the microbic theory in general; and for a number of years, the question of the mode of transference was the favorite field for speculation.

In 1892, Schmidt-Rimpler,[127] following similar suggestions by v. Rothmund,[128] the writer (*Arch. of Oph.*, 1887, p. 291) and Meyer,[129] proposed the *combined ciliary nerve-germ theory,* which assumed that various germs circulating in the blood but finding no lodging place in the eye under ordinary conditions, might start a sympathetic inflammation under the influence of the reflex congestion produced in the eye by a traumatic inflammation in the first eye. This produced a crop of experiments of which those of Bach[130] and of Moll[131] may serve as examples, tending to show that sympathetic irritation favored the passage of germs from the blood stream into the tissues of the eye.

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123 Schirmer, *Arch. für Oph.*, 38, 4. 95.

124 Basevi. *Annali di Ottal.*, 19. 1890, 57.

125 Parisotti, *Trans. Internat. Med. Cong.*, Berlin, 1890. 4, X, 123.

126 Gayet, *Arch. d'Oph.*, 10, 107.

* For a fuller account of the early and later bacteriology of sympathetic ophthalmia see Schirmer (pp. 121 and 188); Gilbert (*Archiv f. Ophthalm.*, 77, 249); and F. Deutschmann (*Archiv f. Ophthalm.*, 78 and 79). The last. in particular claimed to have produced typical sympathetic ophthalmia in rabbits and apes by inoculating one eye with sympathogenic tissues; exudate containing a Gram-positive diplococcus was found along the optic nerves and chiasma; and a sarcina-like germ was cultivated from the same. His bacteriologic results have been strongly criticised by Salus and others but, aside from his bacteriology, the positive inflammation obtained with sympathetic ophthalmia tissue, if his results can be confirmed, added to the experience of Schirmer (p. 128) makes the most striking evidence for the germ theory thus far obtained. In general it can be said that while some one of the common inhabitants of the conjunctival sac has occasionally been found in the first eye, the latter, as a rule, is not found to contain any demonstrable germ; while in the second eye, except in such doubtful cases as that of Deutschmann (*Beitraege z. Augenheilk.*, Vol. 1. 171) or of Zimmermann (*Archiv f. Ophthalm.*, 42, 2, 39), where the germs were probably a post-mortem development or a secondary infection from meningitis, respectively, no germ has been found.

127 Schmidt-Rimpler, *Arch. für Oph.*, 38, 1, 212.

128 v. Rothmund, cit. by Schirmer, p. 178.

129 Meyer, cit. by Schirmer, 192.

130 Bach, *Arch. für. Oph.*, 42, 1, 267.

131 Moll, *Centralbl. f. prakt. Augenheilk.*, 1898, 353.

Römer,[132] on the other hand, in a fine series of articles, strongly contended that sympathetic ophthalmia must be produced by a specific germ through a blood-current metastasis, uninfluenced by the ciliary nerves.

Biological theories of sympathetic ophthalmia. In 1898 and subsequently, the writer,[133] in discussing Schmidt-Rimpler's theory, suggested that the innumerable instances of long standing ciliary irritation of various origin, without the occurrence of sympathetic ophthalmia rendered it highly improbable that any old germ which might happen to get into the circulation, would cause sympathetic ophthalmia if the second eye happened to be the subject of sympathetic irritation. To establish any decided probability for the theory, it would be necessary to add either the supposition that the germs were such as had, from the start, an especial affinity for the uveal tract; *or that they were germs which had acquired, through natural selection, in the struggle for existence in the first eye, a special ability to combat the resistance offered by the uveal tissues of the second eye.* Somewhat the same idea was independently advanced by O'Connor [134] in 1916. Utilizing the fact found by Rosenow, in his research on focal infections, that germs which had caused a pathological process in some particular organ or tissue, showed a tendency to locate in the same tissue or organ when introduced into the circulation of another animal, O'Connor suggested that sympathetic ophthalmia results from a lodgement in the second eye of a germ, perhaps ultra-microscopic, which had become especially adapted for growth in uveal tissue by fighting the antibodies produced in the first eye by a traumatic inflammation.

Meller makes the same supposition a part of his endogenous theory of sympathetic ophthalmia when he assumes that the sympathetic ophthalmia germ, lodging from the circulation in the injured eye, there acquires the power to destroy uveal tissue, which enables it to produce sympathetic ophthalmia.

Theory of inter-orbital transmission. Scheffels [135] suggested the nose-bridge lymphatics as a path of transmission and Hirschberg,[136] in 1895 advised searching for other lymphatic communications between the orbits. Arnold [137] believed that the noxa of sympathetic ophthalmia might be forced back to the second orbit through veins in the brain cavity by disturbances in intra-cranial pressure. Motais [138] and

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132 Römer, *Arch. für Augenheilk.*, Vols. 54, 55, 56; *Arch. für Oph.*, Vols. 55, 56.
133 Gifford, H., *Journ. Am. Med. Ass'n,* Feb. 10, 1900, and *Oph. Rec.*, 1916, 344.
134 O'Connor, *Oph. Rec.*, 1916, 196.
135 Scheffels, *Klin. Monatsbl. f. Augenheilk.*, 1890, 246.
136 Hirschberg, *Centralbl. f. prakt.*, Aug., 1895, 80.
137 Arnold, *Arch. f. path. Anat.*, 124, 3.
138 Motais, *Trans. Internat. Oph. Cong.*, Lucerne, 1904, 314.

Gilbert [139] also urged intra-cranial pressure-variations, as favoring the passage of germs from one eye to the other, by way of the venous communications which are present across the nose bridge, through the circular sinus; and through the ethmoidal veins, by way of the nasal septum and over the crista galli. Gilbert would explain the headache and slight delirium which occasionally occur with sympathetic ophthalmia as the result of such venous engorgment, rather than as signs of slight meningitis.

Meller's endogenous theory. The discovery of the sympathetic ophthalmia type of inflammation in sarcomatous eyes which have caused sympathetic ophthalmia, as well as in some eyes which had developed irido-cyclitis without a wound of either eye, suggested to Meller [140] that not only in these eyes, but in most cases of ordinary sympathetic ophthalmia, the germ enters the system, not through the eye-wound, but through a lesion of the skin or some non-ocular mucous membrane, and reaches the eyes from the blood. To account for the connection between sympathetic ophthalmia and penetrating wounds, he assumes that the specific germ cannot ordinarily develop directly from the blood in a healthy eye, but that after entering into the blood, it develops in the wounded eye, on account of the disturbed nutrition, and after growing there for a certain length of time, it acquires an increased power of attacking healthy eye tissue, and then re-enters the blood and is re-distributed to both eyes. The writer would submit that, for the sake of explaining the rare cases of sympathetic ophthalmia with sarcoma, and those of spontaneous uveitis with sympathetic ophthalmia characteristics; it is hardly worth while to drag sympathetic ophthalmia into so labored an hypothesis. Why not simply assume that in rare cases the sympathetic ophthalmia germ (or another similar organism), may get into the system through some other part than the eye, as had already been suggested by Römer and Heerfordt, and thus cause a uveitis with sympathetic ophthalmia characteristics; while in the vast majority, it enters the body through the eye-wound as it would naturally be supposed to do. Meller's explanation of the almost invariable association of sympathetic ophthalmia with penetrating wounds accords poorly with the extreme rarity of sympathetic ophthalmia in all kinds of injury and disease of the uvea, as long as there is no penetrating wound; and it is open to the objections which apply to all forms of the metastatic theory.

At the other extremity of the scale as regards simplicity, may be mentioned the *direct entrance theory* of Heerfordt (*loc. cit*) who, on

[139] Gilbert, *Arch. für Oph.*, 77, 288.
[140] Meller, *Arch. für Oph.*, 72, 167.

account of the early date of the appearance of optic neuritis in the second eye, supposed that part of the germs, on entering the first eye, without stopping to develop there, must have gone directly into the blood-current on the way to the second eye.

Toxinic theories of sympathetic ophthalmia. Eversbusch and von Rothmund, in 1882,[141] advanced a theory of sympathetic ophthalmia; according to which toxic products from the first eye reached the second by the lymph- or blood-stream, or by damaging the vaso-motor ganglia, or that similar products may damage the second eye by reflex action from the irritated first eye.

Bellarminoff and Selenkowsky [142] believe that sympathetic ophthalmia is caused by the continuous carrying over of bacterial toxins from one eye to the other by way of the optic nerves and chiasm.

Guillery *(loc. cit.)* also claims to have often caused the characteristic clinical and microscopic picture of sympathetic ophthalmia by intravenous injections of various bacterial products. He believes that the disease is neither microbic nor anaphylactic but is caused by the action of ferments which probably are the result of some sort of auto-intoxication.

Cytotoxic theories. Strong as was the internal evidence in favor of the germ theory of sympathetic ophthalmia, the failure of the vast majority of the numerous attempts to discover any particular germ in the first eye, coupled with the increasing knowledge of the phlogistic effects of auto-toxins, especially those caused by the splitting up of various proteins in the body, naturally led to theories of sympathetic ophthalmia from which microbes were eliminated. So far as the writer can learn, the first of these biochemic theories was that proposed by Brown Pusey.[143] Castaigne and Rathery had found that when the entire pedicle of one of the kidneys of a rabbit was ligated and the degenerating kidney left in place, well marked degenerative changes took place in the opposite kidney; while if the ligated kidney was immediately removed, no such changes occurred. Basing his theory on this work, Pusey suggested "that when a damaged eye degenerates in the orbit, the cells of the eye, probably the lining cells of the ciliary processes and the iris," can give rise to a specific cytotoxin which circulating in the blood picks out the cells of the fellow eye and may cause changes which we now designate as sympathetic ophthalmia. Pusey's attempt to prove his theory, by the injection into dogs of goat serum from animals immunized with dog's uveal tissue, gave a nega-

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141 v. Rothmund and Eversbusch, cited by Schirmer, 178.

142 Bellarminoff and Selenkowsky, *Arch. für Augenheilk.*, 44, 1.

143 Pusey, *Arch. of. Oph.*, 32, 334.

tive result; but his idea remains noteworthy as the pioneer of the biochemic theories of sympathetic ophthalmia. About a year later Golowin[144] proposed a similar "cyclotoxic" theory which embraced the additional supposition that the eye injured by the toxins, thus became more easily the prey of germs circulating in the blood.

The most formidable of this class of theories, however, is the theory that sympathetic ophthalmia, is the result of *anaphylaxis*.

It was inevitable that this key to so many pathological secrets should be applied to sympathetic ophthalmia, and the idea of such an explanation occurred, about the same time, to two pathologists, Bail and Heim, who suggested it to Elschnig and Kümmell respectively; but since, of the enormous amount of careful research which these men performed, the major part was done by Elschnig,[145] the theory commonly goes by his name. His statement of the theory is as follows: "I assume that the cause of sympathetic ophthalmia is not infectious, that is, it has not a bacterial origin but, on the contrary, depends upon some anomaly affecting the whole organism; which can easily be detected, as in nephritis, diabetes, or something of the sort; or else is produced by auto-intoxication in the widest sense of the word; or by some anomaly of the constitution, * * * a trauma severely injures the first eye, at the same time, perhaps, infecting it with one of the ordinary infectious germs; or the eye, in virtue of the anomaly of the body, develops from the trauma as such, a non-bacterial inflammation. The disintegration of the tissue which accompanies the inflammation leads to absorption of uveal tissue and thus to a hyper-sensitiveness of that part of the uvea not immediately affected by the injury or the primary inflammation of the first eye, as well as of the uvea of the second eye. As a result of this local hyper-sensitiveness of the uvea, the existing somatic anomaly finds a point of attack and leads to that inflammation of the uvea of both eyes which is known as sympathogenic ("sympathisirende") inflammation."

Experimentally the theory, as yet, has very little support. In brief, Elschnig has found, after much careful and laborious investigation, that on repeated injections of heteroserum into the rabbit's eye, the latter shows an anaphylactic reaction in the shape of an irido-cyclitis of limited duration; the reaction being more pronounced when the animal has been previously immunized by injections of the same serum into the blood. Injections of uveal tissue-emulsions, as well as of chemically pure eye-pigment, sensitize the system, as shown by the complement-fixation method, to eye-pigment; not only of the same

144 Golowin, *Klin. Monatsbl. f. Augenheilk.*, Feb., 1909.

145 Elschnig, *Arch. für Oph.*, Vols. 75, 76, 78, 79, 81, 88.

species, but to eye-pigment of other animals. This sensitization can be produced with pigment of the same species of animal, but not of the same individual nor to so marked a degree as when the pigment of another species is used. The reaction is organ-specific but not species-specific.

Kümmell[146] has obtained similar results; and in rabbit's eyes in which anaphylaxis was produced by repeated injections of heteroserum, has found a lymphocytic nodal infiltration of the uveal tract, quite similar to that observed in sympathetic ophthalmia. With homo-serum or homo-tissue he obtained no anaphylaxis; and in testing the serum of patients with sympathetic ophthalmia, he was not able, definitely, to demonstrate a sensitiveness to uveal emulsions.

In support of his supposition of an organic anomaly or auto-intoxication, Elschnig has repeatedly tested the urine of his patients for indican, and believes that the results thus obtained show an abnormal frequency of auto-intoxication, in patients with uveal inflammation.

In the main, these observations of Kümmell and Elschnig have been confirmed by subsequent investigators. In particular, Elschnig's work has been gone over and added to by A. C. Woods,[147] of Philadelphia. He has shown that where one eye of a rabbit has been sensitized by an intra-vitreous injection of dog's uveal pigment, and the head of the animal, some weeks later, is perfused with a solution of the same pigment; the second eye regularly shows a contraction of the pupil and retinal hemorrhages. Also that where one eye of a dog received an intra-vitreous injection of homologous uveal tissue there occurred, after a lapse of two or three weeks, ciliary congestion, photophobia and sluggish pupil of the other eye. And in two cases of this sort where the dogs were given a large intro-peritoneal injection of dogs' uveal pigment, the inflammatory symptoms of both eyes became much more violent and while these symptoms disappeared in one of the dogs, in the other, which died of general reaction, both eyes developed an intense plastic irido-cyclitis with an ulcer of the cornea in the second eye; while the uveal tract showed an infiltration slightly resembling that of sympathetic ophthalmia. Although Woods reports these cases under the heading "Experimental Sympathetic Ophthalmia by Anaphylactic Means," he does not claim that they constitute proof of the theory and freely admits that one of the most important links in the chain, that of auto-sensitization with the uveal pigment, has not been produced.

Abundant criticism of the anaphylactic theory has not been wanting,

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[146] Kümmell, *Arch. für Oph.*, Vols. 77, 79, 84.

[147] Woods, *Arch. of Oph.*, 45, 557; 46, 8; and *Trans. Oph. Soc. A. M. A.*, 1917, 133.

Rados,[148] v. Szily[149] and others have not been able to confirm all of Elschnig's and Kümmell's results; but like the arguments for theory the main criticisms of it have been theoretical. Von Hippel,[150] Reis,[151] and others have offered a number of objections to the theory, of which the following are the most important. The horror-autotoxicus, i. e., the difficulty or impossibility of producing anaphylaxis with an animal's own tissue is one of the most firmly established principles of the subject. The results of Elschnig, Kümmell and their supporters merely emphasize this rule.

Anaphylactic manifestations generally are sudden and explosive; differing entirely, in this, from the usual course of sympathetic ophthalmia.

The almost exclusive occurrence of sympathetic ophthalmia after penetrating wounds is hard to explain on the anaphylactic theory, according to which we should expect sympathetic ophthalmia from all sorts of chronic diseases and injuries of the uveal pigment without penetrating wounds.

Elschnig's supposition of a somatic anomaly or "auto-intoxication in the widest sense of the term" to account for the occurrence of sympathetic ophthalmia in some persons and not in others in equally favorable conditions for anaphylaxis, is opposed to the common experience of most authorities that sympathetic ophthalmia occurs far more frequently in the apparently well, than among those showing any trace of disease; and as the main proof which Elschnig offers of a constitutional anomaly in sympathetic ophthalmia rests upon the notoriously uncertain value of the indican test, this constitutes one of the weakest parts of his theory.

Since Elschnig and his followers insist that it must be the uveal pigment which is responsible for the outbreak of sympathetic ophthalmia, it remains inexplicable that this pigment should show no signs of violent disintegration and absorption; and that the layer in which this pigment is most abundantly present, namely the pigment layer of the retina, should be hardly at all affected except in the later stages of the disease.

If it be urged that the small foci of chorio-retinitis with atrophy of the retinal-pigment, which so commonly occur in sympathetic ophthalmia are the results of anaphylaxis in the pigment layer, it remains for the supporters of the theory to explain why this phenomenon, in an eye in which all the uveal pigment must be sensitized at the same time, should reveal itself in such fragmentary and insignificant areas.

[148] Rados, *Zeit. f. Immun. and Exp. Therap.*, 20, 416.
[149] v. Szily, *Klin. Monatsbl. f. Augenheilk.*, Jan., 1916.
[150] E. v. Hippel, *Arch. für Oph.*, 79, 451.
[151] Reis, *Arch. für Oph.*, 80, 69.

In the same line is the point made by Ruge, that although sympathetic ophthalmia-changes are chiefly uveitic, different regions of the tract may suffer in quite different degrees; the inflammation in some cases being mostly anterior, in others posterior, while in some, both anterior and posterior portions are affected, but the equator remains free.

Schieck [152] opposes the anaphylactic theory on the ground that since anaphylactogen from the eye is communicated to the whole system within three hours after the antigen has been injected into the anterior chamber; and the process of sensitization is then completed outside the eye within fourteen days at the outside; the second eye would then be at the mercy of the slightest disturbance of the uveal pigment for a period of months, years, or a life-time. Under these circumstances the enucleation of the first eye could obviously be of little use (and Elschnig himself supports this position); but as experience shows that it is of the greatest possible use, the theory falls.

Another stumbling block for the anaphylactic theory is the occurrence of sympathetic optic neuritis. Elschnig himself points out that nerve substance apparently produces no specific albumen and admits that if such a neuritis occurs it can not be anaphylactic. He believes that many, if not all, of such reported cases are the result of accessory sinus disease; but papillitis is too common a symptom of sympathetic ophthalmia to be thus explained away. And if it be held that this papillitis and the slight inflammatory infiltration, so commonly shown by the microscope in the peripheral portion of the nerve in sympathetic ophthalmia, is the result of an overflow congestion from the choroid, we are met by the opposing fact that in the numerous cases in which we see non-sympathetic chorio-retinitic foci develop all through the posterior pole of the eye, the occurrence of papillitis in such cases is very rare.

The deafness which occasionally accompanies sympathetic ophthalmia has been explained by Peters as the result of anaphylaxis of the pigment of the labyrinth; but such cases are much more readily explained as the result of an extension of a meningitis, which on the Leber-Snellen theory, probably occurs to a slight extent in many if not all cases of sympathetic ophthalmia. If this deafness were an anaphylactic phenomenon why should it be so extremely rare? The same objection applies to the anaphylactic explanation of the whitening of the lashes and falling out of hair which has been observed by Cramer in a case of sympathetic ophthalmia.

In view of the solidity of the wall which the almost invariable oc-

[152] Schieck, *Zeit. für Augenheilk.*, 29, 196.

currence of a preceding penetrating wound opposes to the anaphylactic theory, the writer hazards the suggestion that the next thing will be a combination microbic-anaphylactic theory, based on the assumption that a (possibly specific) microbic action in the injured eye is necessary to produce the uveal antigen required for the anaphylaxis.

Summary of theories of the etiology of sympathetic ophthalmia.

Dividing the theories of the origin of sympathetic ophthalmia into microbic and nonmicrobic, the latter may be disposed of as follows: the simon-pure reflex, or ciliary-nerve, theory has no place in modern pathology. The toxinic and cyto-toxinic theories fail to explain the persistence of the inflammatory symptoms after the removal of the first eye. The same applies to some extent to the anaphylactic theory, against which numerous objections have already been advanced. However, if it be assumed that the disease is not microbic, this theory is the best yet offered.

For the microbic theory in general, it must be said that the natural history of the disease, including its almost universal appearance after penetrating wounds; its appearance after considerable interval of time; its persistence; and especially its appearance after the removal of the first eye; together with the pathological findings; are all best explained on the assumption of microbic life in the second eye. The fact that this germ has not been discovered may be due to its ultramicroscopic size or its reaction to ordinary stains; and is an obstacle which refinements of microscopic and bacteriologic technique may remove at any time.

With regard to the path taken by the supposed germs in reaching the second eye, the optic nerve route, if we include the lymph vessels of the orbital tissue, has the most attractive anatomic basis. That germs may also pass from one orbit to the other by way of the veins must be conceded as a possibility. That they may reach the second eye by way of the general blood current either from the first eye, or from some other part of the body, cannot be denied. The main question is whether it is more probable that the germ takes the optic nerve route, or the metastatic route. In favor of the former, the direct connection and open path afforded by the nerves and their lymph-spaces is the most striking fact. Soluble poisons have been shown to take this route in animals. The passage of pigment particles from the cranial cavity to both eyes can be demonstrated, both in life and death, with the utmost ease; and we know that in man, germs sometimes go from the eye to the brain-cavity; and from the brain-cavity to the eye. The infrequency of meningitis and the comparatively slight changes

in the nerves as compared with the uvea may be explained by the assumption of a germ that has a specific affinity for uveal tissue, either inherent or acquired, but which can, on a pinch, exist in other tissues.

If a large enough number of optic-neurectomies could be done to show that the danger of sympathetic ophthalmia was not greater after this operation than after enucleation, it would constitute the strongest possible proof that the germ follows the optic nerve route in reaching the second eye.

For the metastatic theory, the anatomic argument is based on the fact that the sympathogenic inflammation is frequently seen to invade and destroy the walls of the blood vessels; and upon the occurrence of this inflammation in the form of numerous nodes; each one of which might be supposed to indicate a separate metastatic focus. But as this nodular formation is occasionally found fully developed in the first eye, when the second is entirely healthy, and as it is very often found far advanced in eyes enucleated at the first sign of sympathetic ophthalmia in the other, we must, in order to make any use of the nodes as an argument for metastasis, assume that the germ gets into the blood from the first eye and then is distributed back to the first eye alone, thence starting a second crop of metastases for the second eye; which will hardly need to be considered. Of greater weight is the point brought out by Fuchs that the sympathogenic type of inflammation is rarely found in an enucleated eye with traumatic uveitis, unless the second eye has sympathetic ophthalmia. In other words, Fuchs thinks that the characteristic pathology tends to appear almost simultaneously in both eyes, and this is regarded by him as strong evidence of a metastatic origin of the disease. The point needs further investigation. While Fuchs has seen the sympathogenic type of pathology limited to one side in only three or four cases, Gradle (*Journ. Oph. and Oto-Lar.*, Feb., 1913) speaks of seeing it a number of times in eyes enucleated in the absence of sympathetic ophthalmia. *Even if one-sided sympathogenic pathology were as rare as Fuchs supposes, the numerous cases where it is found well advanced, in eyes enucleated at the very onset of sympathetic ophthalmia, show that the assumption of a simultaneous metastatic infection of both eyes can not be maintained.* These considerations also preclude the use of the nodal type of inflammation and the scarcity of one-sided sympathogenic pathology, as supports for Meller's endogenous theory. Still more potent in this respect are the cases of sympathetic ophthalmia occurring weeks after enucleation.

To the writer, it seems that until we have some such evidence as would be furnished by statistics showing conclusively that optic neu-

rectomy is as good a prophylactic as enucleation, we must admit the possibility that germs may at times take different routes to the second eye, or even that in a given case more than one route may be taken.

Regarding the combined ciliary-nerve germ-theory first suggested by v. Rothmund and elaborated by Schmidt-Rimpler; as proposed by the latter, it fails to explain why the irritation which he assumes to be the cause of the location in the second eye, of most any germ which may happen to be in the blood, has to be furnished by a penetrating wound. On this theory we should expect to find sympathetic ophthalmia resulting from any of the numerous causes of reflex irritation from the first eye. But it is well recognized that cases in which sympathetic irritation is prominent are not at all likely to cause sympathetic ophthalmia, even when the irritation follows a penetrating wound; while in the cases of real sympathetic ophthalmia, a marked premonitory sympathetic irritation is generally lacking. But while these considerations, in the writer's opinion, render the Schmidt-Rimpler theory untenable, we may admit the possibility that the location of the sympathetic ophthalmia germ may be favored, or its action reinforced, by reflex disturbance of the circulation in the second eye. Until we have the sympathetic ophthalmia germ and susceptible material for experimentation, this, like so many other possibilities in this subject, is incapable of proof or of refutation.

Sympathetic ophthalmia during the great war (1914-1918).

A number of ophthalmic surgeons in service during the late war have expressed surprise at the small number of cases of sympathetic ophthalmia resulting from the numerous eye injuries which came under their observation. Weekers,[153] Jessop,[154] Dimmer,[155] and many others have contributed to this subject. The sum of their opinions seems to be that while much of the surprise at the relative infrequency of sympathetic ophthalmia was caused by comparison with the misleading statistics of the Franco-Prussian war; in which the very high precentage of reported sympathetic ophthalmia was undoubtedly due, in part, to the inclusion of a number of cases of sympathetic irritation and other things which were really not sympathetic ophthalmia, there still remained a relative immunity to the disease, due perhaps in part to the better management of the wounds, and in part to the better physical condition of the men; the latter being due both to the better food and to the greater care taken to eliminate focal infections.

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153 Weekers, *Ann. d'Oculist.*, 154, 196.

154 Jessop, *Arch. d'Oph.*, 35, 193.

155 Dimmer, *Am. Jour. Oph.*, Apr. 1918, Lit. Digest, 77.

On the other hand the report of Morax (cited in the subsection on *Sympathetic ophthalmia after enucleation*) indicated that sympathetic ophthalmia was not so rare as other writers had supposed; and Oguchi[156] reported that in the Russo-Japanese war, in which, on the Jap side at least, the medical service was excellent, sympathetic ophthalmia was very common.

Nature of the supposed germ in sympathetic ophthalmia. Since sympathetic ophthalmia is not contagious, the germ which causes it must either have an intermediate host; or else it cannot be obligatorily pathogenic; and since the multifarious articles which cause the wounds which precede the disease can not all be supposed to be contaminated with this germ, the latter probably is a constant or frequent inhabitant of the conjunctival sac, where it leads a harmless, saprophytic existence, until a wound opens the way to the uveal tract. It may exist on other mucous surfaces from which it may, in exceptional cases (or frequently, according to Meller), reach the blood current and the eyes. The fact that it has not been detected with the microscope, suggests that it is either ultra-microscopic or else that it so closely resembles some of the body cells as to be mistaken for them. The facility with which it seems to penetrate exposed bits of uveal tissue suggests that it is actively motile (Heerfordt). It probably has an inherent or acquired affinity for uveal tissue and from the numerous negative results of attempts at producing sympathetic ophthalmia with sympathogenic tissue, it probably attacks only man and perhaps, the higher apes.—(H. G.)

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Sympathetic spasm of the lids. This was described by Graefe as a symptom in exophthalmic goitre. When the patient looks directly forward, the upper lid does not reach the cornea, but leaves a space of sclerotic uncovered, and when he looks down, the lid does not follow, or follows only partially, the movements of the ball. The lower lid is slightly depressed. This symptom is met with more frequently in the

early stages of the disease, but is not a constant symptom in goitre. Wecker has observed it also in hysterical and in pregnant women, and in cases of locomotor ataxia. It is attributed to spasm of the unstriated muscular fibres of Müller.

Sympathicus. (G.) Sympathetic nerve.

Sympathizing eye. See **Sympathetic ophthalmia.**

Sympathotomics. Individuals whose pulse rate increases as a result of the oculocardiac reflex. See p. 8470, Vol. XI of this *Encyclopedia.*

Symptom, Kocher's. A sign of exophthalmic goitre: the examiner places his hand on a level with the patient's eyes and then lifts it higher; the upper lid springs up more quickly than does his eyeball.

Symptom, Liebreich's. A symptom of red-green color-blindness in which light effects appear red and shadows green.

Symptom, Skeer's. A small circle in the iris surrounding the pupil: it is regarded as pathognomonic of tuberculous meningitis.

Symptom, Van der Hoeve's. See **Hoeve's (Van der) symptom.**

Symptom, Weber's. See **Weber's symptom.**

Symptom, Wernicke's. See **Sign, Wernicke's.**

Synaugeia. That part of the earth's or moon's surface where the sun is wholly above the horizon.

Syncanthus. An old term for an abnormal adhesion between the ocular conjunctiva and the other orbital structures.

Synchysis. A mingling of the humors of the eye in consequence of disease or of the rupture of an inclosing membrane or capsule.

Synchysis corporis vitrei. Fluid vitreous. Fluidity of the vitreous occurs as the result of choroiditis or retinitis, and is found in high myopia by reason of the fact that in these conditions the nutrition of the vitreous is disturbed. Under these circumstances the vitreous body becomes a thin fluid of a straw color. In cataract extractions it is sometimes observed that considerable watery fluid, in excess of the amount of aqueous, flows out of the wound. In such patients the anterior part of the vitreous has become thin. With diminished consistency there may be shrinkage of the vitreous. The anterior chamber may be increased in depth from a backward movement of the lens, and detachment of the retina may be present. According to Griffith, in cases of fluidity of the vitreous the ocular tension is more often increased than diminished. Tremulousness of the iris is often present in this disease. The condition does not admit of successful treatment. —(J. M. B.)

Synchysis etincelant. (F.) Synchisis scintillans.

Synchysis scintillans. Sparkling synchisis. A fluid condition of the vitreous humor in which it is filled with crystals of cholesterin that sparkle brilliantly and beautifully under the ophthalmoscope. In

addition to cholesterin, margarin, tyrosin, and phosphates are sometimes found. Ophthalmoscopically the appearance is usually that of innumerable small, moving, shining particles which have been likened to a shower of gold, although cases have been observed in which the particles appeared as white, glistening, silvery, round discs, or small, cream-colored bodies. Sparkling synchysis is a senile condition, having been observed only in persons over fifty years of age. As a rule vision is normal. The affection may be unilateral or bilateral, and is irremediable.—(J. M. B.)

Hay has pointed out that cholesterin particles in the vitreous may be strikingly demonstrated with the Morton ophthalmoscope, by reflecting the light from the small mirror, after rotating it away from the aperture, and looking through the aperture, in front of which is brought an 8 D. or 10 D. lens.

In a case seen by Sommer (*Wochenschr. f. Therap. des Auges,* July 15, 1909) the opacities in the vitreous had a glistening silvery appearance and not golden as described by most authors. Wiegemann has seen both golden and silvery showers and believes that the chemical composition as well as the illumination is a factor in producing these variations. With an oil light they are of a reddish-yellow, and by electric and gas light, of a whitish appearance. Oppenheimer says that he has seen about 6 cases in ten years' practice and only once had the crystals a golden appearance. All were observed under an argand light.

H. A. Westpfahl (*Archiv f. Augenheilk.,* 78, p. 1, 1915) examined a marked case of synchisis scintillans in an eye affected with hemorrhagic glaucoma and developing phthisis bulbi, and found microscopically and chemically that the crystals consisted of pure cholesterin. From statistics of his clinic (65,000 patients within nine years) synchisis scintillans occurred in 40, i. e., 0.66 per 1,000. In 90 per cent. the affection was unilateral, and was observed at an average of 61 years. It was always associated with other senile changes, so that it may be considered as a phenomenon of degeneration.

Its occurrence at an earlier age depends on marked degeneration of the whole eyeball, i. e., post-traumatic detachment of the retina, phthisis bulbi, etc. In 47 per cent. the eyes, especially the fundus, and vision, were normal. In 25 per cent. it was combined with senile cataract, which, at an average age of 70, apparently was accidental. In 28 per cent. it was complicated by intraocular diseases, but these could only in the minority of instances be regarded as causes of the formation of cholesterin, while in the majority an accidental coincidence must be assumed.

Synchysis simplex. A softened or fluid state of the vitreous humor with small floating opacities; very often a senile change.

Synchisis, Sparkling. See **Synchisis scintillans.**

Syncleisis. Occlusion.

Syncope. Fainting. Failure of the heart's action producing pallor, coldness of the skin, prostration and unconsciousness, mostly the result of cerebral anemia. During fainting attacks there is, according to Poncet, contraction of the retinal arteries with or without narrowing of the veins. Wadsworth has noticed, also, arterial pulsation. See, also, **Raynaud's disease,** p. 10884, Vol. XIV of this *Encyclopedia.*

Syndectomy. Peritomy. Peridectomy. Excision of a circular strip of the conjunctiva, usually for the cure of pannus. Called also circumcision of the cornea. See p. 9613 and p. 9416, Vol. XII of this *Encyclopedia.*

Syndrome. A concurrence or complex of symptoms; a sum of signs of a morbid state.

Syndrome, Benedikt's. Paralysis of the parts supplied by the oculomotor nerve of one side, with paresis and tremor of the upper extremity on the other. See, also, **Weber's symptom.**

Syndrome, Bernard-Horner's. Horner's syndrome. This symptom-complex comprises mitosis, exophthalmos, ptosis, miosis and anhidrosis—the result of paralysis of the cervical sympathetic.

Burger points out (*Arch. méd. belges,* April, 1917) that this syndrome can be encountered but rarely in military surgery since the injury able to produce it usually proves fatal from hemorrhage. It should, however, be borne in mind when dealing with injuries in the neck. He describes a case which came under his observation. The injury in this instance was caused by a fragment of glass, during an automobile accident. The wound extended on the left side from the angle of the jaw to the mastoid and had detached the sterno-mastoid muscle from its superior insertion. The bifurcation of the carotid was exposed in the lower part of the wound, and it was necessary to tie branches of the thyro-linguo-facial vein, of the thyroid, lingual, facial and occipital arteries, and also of the external jugular. The hypoglossal nerve was exposed and its descending branch partly divided. Neither the pneumogastric nor the sympathetic nerve was seen. On the following morning the Claude Bernard-Horner syndrome was well established: *Slight ptosis, enophthalmos, miosis with preservation of pupillary reflexes.* The intraocular pressure was equal in the two eyes. *Lachrymal secretion was excessive.* Visual acuity was unaffected, but there was *diplopia* on looking up and to the right; no

apparent strabismus. Three weeks later a full examination of the nervous system was made. The left eye then showed slight ptosis, enophthalmos, and miosis with preservation of reflexes. Lachrymal hypersecretion and diplopia had disappeared. There were no vaso-motor or sweat disturbances. Accommodation and convergence were normal. Instillations of adrenalin followed by cocain produced no effect on the pupil even after several hours. On the following day cocain was first used and adrenalin later. This had the effect of slowly dilating the pupil, but only to a moderate extent. In addition to the ocular symptoms there was paralysis of the left vocal cord, sterno-mastoid and trapezius and some of the facial muscles.

In the body of the report Burger gives a brief account of the current views of the anatomy and physiology of the sympathetic in the neck. He explains the transient diplopia from which his patient suffered as due to the altered mechanical conditions under which the extrinsic ocular muscles had to work, owing to the enophthalmos caused by paralysis of smooth muscle fibres in the orbit. A diagram is given to explain this hypothesis. He sums up as follows: "The cervical sympathetic tract as it leaves the spine is composed of two series of neurones. The first, part of the medullary centre (cilio-spinal centre of Budge), reaches the superior cervical ganglion by the three or even seven first pairs of dorsal nerves, by their rami communicantes and the cervico-thoracic sympathetic cord. The second series leaves the superior cervical ganglion to reach the eye.

"The syndrome of paralysis of that sympathetic tract is composed of: 1. Motor phenomena, ptosis, enophthalmos, miosis with preservation of reflexes. 2. Vaso-motor and sweat phenomena. Finally, hypotony of the globe and occasionally facial hemiatrophy. This syndrome is nearly always dissociated. We believe that this can only be produced as a result of a partial lesion of the fibres. At the level of the cord where all the fibres are united a dissociation can only take place as a result of a slight lesion, and possibly of the particular susceptibility of certain elements.

"The action of cocain and adrenalin is of great importance in characterising the iris disturbances that are seen in sympathetic lesions, and possibly also in the determination of which of the two neurones is affected. Experiments on animals seem to prove that adrenalin shows whether the lesion is above or below the ganglion."

Syndrome, Commotional. The socalled "shell-shock." See p. 7771, Vol. X of this *Encyclopedia.*

Syndrome, Foville's. Crossed paralysis of the limbs on one side of the body and of the face on the opposite side, together with loss of power to rotate the eyes to that side.

Syndrome, Fröhlich's. Dystrophia adiposogenitalis. Adiposity, atrophy of the genitalia, changes in the secondary sexual characters followed by (in males) development of the feminine type. This syndrome is found in lesions of the pituitary body and is sometimes associated with blindness. A very good account of a case exhibiting the eye conditions usually accompanying this rather rare disease is given by J. J. Madigan and Thos. Verner Moore (*Journ. Am. Med. Assocn.*, p. 669, Mar. 9, 1918), which is reported here almost in full, with the writers' comments.

A boy, aged 10, was brought for general mental backwardness. He was the first born child. He was followed by a brother born at about the eighth month, who died when two weeks old. The next birth was a miscarriage, after which there were no more pregnancies. Venereal disease in the father or mother was denied. The family history of the father was negative. On the mother's side there was a history of various abnormalities. Her father had four brothers and three sisters, two brothers and two sisters being normal, while the other two brothers were described as having deformities of the feet, one of them also having some kind of convulsive seizures; and the other sister went blind at about 30. The mother of the patient was one of seven normal children. She had one maternal aunt and five maternal uncles, all normal.

In brief, then, we have a family history which is negative excepting the mother's paternal relatives, suggesting a defect in the germ plasm, which might be a Mendelian recessive. This is confirmed by the fact that a daughter of the above mentioned aunt married a man whose ancestry is perhaps suspicious (his father died of "creeping paralysis" at 66), and their only child has had from birth an incurable chorea with spasticity of the legs, and though 8 years old, has never spoken.

The patient was a full term child, with normal delivery. His mother does not remember when he cut his first teeth, but he first walked and began talking at about 5 years of age. He did not stop bed-wetting until after his ninth birthday. He had "typhoid pneumonia," as the mother describes it, when 2½ years of age; chickenpox when a baby: measles and whooping-cough when 9. The present condition dates back apparently to birth. The child was only 3 or 4 months old when the father noticed the jerky movements of the eyes. He never complained of headache or any pain, and there was no history of vomiting that would lead one to suspect intracranial pressure. He had never

been able to see, but played about his home in the country with ease. and at first sight one would not notice that he was blind.

Physical symptoms. What struck the eye on looking at the patient was the general appearance: the excessive fat for a boy of his age.

Dystrophia Adiposogenitalis. (Madigan and Moore.)

Patient, showing the typical adiposity of adiposogenital dystrophy, and the "maxillary prognathism," or, rather, retarded development of the mandible. The upper lip overhangs the lower.

the feminine form and tapering fingers. When we add to that the fact of his blindness and find that he has a genital aplasia, we have the cardinal symptoms of Fröhlich's syndrome—dystrophia adiposogenitalis.

The symptoms are grouped according to Cushing's scheme:

1. Neighborhood symptoms: There were no subjective discomforts that could be ascertained. Conversation with the patient, owing to defective speech and reduced mentality, was difficult, and there may have been more subjective symptoms than one would suppose.

There was deformation of the sella turcica. The roentgen ray

Dystrophia Adiposogenitalis.

Patient, showing the typical adiposity and the genital dystrophy.

revealed a flattened sella with the posterior clinoid processes destroyed and the anterior pressed down, suggesting a tumor of the hypophysis originating in the sella and growing up out of it and then pressing down on the clinoid processes.

There were evident visual disturbances. Only perception of light remained. The papillæ were much reduced in size and very white.

Dr. Henning, an ophthalmologist in Washington, made the following note: "Optic nerve presents a gray white atrophy of nerve head with small vessels. Retina has mottled appearance like a terrazzo floor, with small pigment lumps scattered irregularly and sparsely." There was no exophthalmos, but the eyes were deep sunken in the orbits. There was now a slow, lateral nystagmus, which had been much more rapid several months before.

Nasopharyngeal symptoms were noted. Cushing mentions cerebro-spinal rhinorrhea as an occasional symptom of pituitary tumor. The mother reported, in this case, a constant somewhat excessive discharge of a clear watery fluid, which of late had somewhat subsided. In the absence of laboratory examinations, one cannot lay much stress on this symptom.

2. General pressure symptoms: The classic pressure symptoms, headache, vomiting and choked disc, are absent. Taking this in connection with the chronic course of the disease, one would expect a benign tumor, which could probably be removed by operative interference.

3. Glandular manifestations: The boy was 137.2 cm. (4 feet, 6 inches) tall. This means that he was about 6 cm. above the average height for 10 year old boys. This excess of growth might be due to a hyperfunction of the pituitary at some time in the patient's history.

The other symptoms pointed to a hypofunction of the gland—the tapering extremities, the marked and typical adiposity. The features were fine, and the skin was smooth, delicate and dry. The hair was abundant on the scalp, but was elsewhere lacking. The condition of the crines, however, was not of such diagnostic importance in a boy of 10 as it would be in an adult.

Another symptom that pointed to hypofunction of the gland was the maxillary prognathism as opposed to the mandibular prognathism of acromegaly. If one looked at the patient's maxilla and mandible, it was evident that the condition was not "due to any forward displacement of the sphenoid," as Cushing supposes, but rather to retarded development of the mandible. The circumference of the head was 50.6 cm. (19 9/10 inches)—about 2 cm., therefore, under the normal of 52.6.

The boy was not in the hospital long enough for a sugar tolerance test.

There was a marked polydipsia. A history of polyuria could not be obtained.

The temperature was normal. The blood pressure was 112 systolic, 70 diastolic.

In testing the mentality of the child, it was found that he could recognize many common objects by touch, repeat three numerals, and place the objects of the form board in their proper position by trial and error.

4. Symptoms referable to other glands: There was a marked sexual aplasia that must have originated in a prenatal disturbance of growth. The penis was rudimentary, but rather large for clitoris. The mons veneris was very pronounced. The testicles were not descended, and a kind of scrotal membrane covered an "open space." The breasts were definitely developed, with evident mammæ.

The thyroid gland was enlarged, palpabic, and of rather firm consistency. The pulse was not accelerated; it was about 80 at the time of the examination.

The suprarenals were not seriously involved, although there was a dirty bronzing of the skin.

Over the sternum, just below the clavicle, there was an area of dulness, extending distinctly to the left, which merged into the cardiac dulness below. This might be due to an enlarged thymus.

There was no evidence of the involvement of other glands.

In 1901, Fröhlich described what he termed "a case of tumor of the hypophysis without acromegaly." The cardinal symptoms that he pointed out were (a) adiposity, (b) genital dystrophy, (c) falling out of the hair after the onset of the disease, and (d) atrophy of the optic nerve. In the later literature, this syndrome became known as dystrophia adiposogenitalis. The condition is associated with a tumor of the hypophysis or one in its neighborhood.

In 1908, Bartels discussed the relation of the changes of the hypophysis to dystrophia adiposogenitalis. He mentions these three theories to explain this relationship: 1. Both tumor and dystrophy are due to inborn, coordinate germinal dispositions (Keimanlagen). 2. Changes in the hypophysis, due to the tumor, account for the dystrophy. 3. Not the changes in the hypophysis, but injury of a neighboring center at the base of the brain causes the changes.

Bartels adopts the first of these hypotheses.

The studies of Cushing render it abundantly evident that changes in the pituitary are frequently the cause of the dystrophy. But the cases which produce this evidence have their onset rather late in life.

There is perhaps room for a small number of cases whose origin is prenatal, and in which a hereditary factor may be detected. In these, both the tumor and the dystrophy may be due, as Bartels maintains, to an inborn coordinate germinal disposition.

The present case suggests precisely this possibility because: 1. There

is an hereditary taint, suggested by the number of deformities in the mother's paternal relatives, and by the appearance of a cerebral defect in one of her paternal relatives who married a man of suspicious ancestry. All this goes to suggest a Mendelian recessive. 2. The origin of the case is prenatal. The reasons for this are: (a) The assertion of the parents that the child never saw; (b) the fact that the father noticed the nystagmus when the child was only 3 or 4 months old; (c) the fact that the genital aplasia is such that it must date well back into the prenatal history of the child, and (d) the very small optic disks.

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Syndrome, Horner's. Mitosis (indirect, nuclear or cell-division), ptosis, exophthalmos, miosis and anhidrosis caused by paralysis of the cervical sympathetic. See **Syndrome, Bernard-Horner's.**

Syndrome, Hutchinson's. Hutchinson's triad. See p. 6068, Vol. VIII of this *Encyclopedia*.

Syndrome, Kennedy's. This writer (*Oph. Year-Book*, p. 231, 1916) formulated a syndrome referable to the inferior frontal areas, which greatly facilitates the diagnosis of pressure-producing lesions of these parts. It is the occurrence of a true retrobulbar neuritis, with the formation of a central scotoma and primary optic atrophy on the side of the lesion; together (if pressure be sufficiently great) with isolateral anosmia and papilledema in the opposite eye. The history of a case illustrates these findings. Examination of the brain, after death, revealed a ruptured aneurysm of the right internal carotid artery, a remarkable rarity in this situation. This aneurysm caused marked pressure on the right optic nerve, just in front of the chiasm; and to a lesser degree on the left optic nerve. It had compressed descending fibers from the right motor area. The lesion by causing direct pressure on the optic nerve produced an obstruction on the vaginal sheath, preventing the fluid from entering the sheath. Hence, the resulting papilledema cannot be caused by a pressure from the fluid, as is usually the case in expanding lesions in the cranial cavity.

Syndrome, Lasegue's. The patient moves his limbs normally when his eyes are open, but cannot move his anesthetic arm when his eyes are shut.

Syndrome, Marie's. Acromegaly caused by disorder of the pituitary secretion.

Syndrome, Occipital. See p. 5666, Vol. VII of this *Encyclopedia.*

Syndrome, Sympathetic. See, also, **Syndrome, Bernard-Horner's.**

Syndrome, Tegmental. Hemiplegia alternating with disordered ocular movements, indicative of lesions of the tegmentum.

Syndrome, Traumatic. A term applied by Henri Frenkel (*Annales d'Ocul.*, p. 233, June, 1916) to a sign-complex affecting the anterior segment of the eye without lesion of the deeper structures of the globe, a condition generally seen in soldiers wearing helmets. The injuries are generally due to shell or grenade fragments. Various injuries of the soft parts are noted, but no bone lesions, as in the cases presenting changes in the retina and choroid. The changes present in this syndrome are: 1. The cornea and sclera are intact, proving the absence of perforation; 2. At some part of the iris a small perforation or a minute iridodialysis; 3. Subluxation of the lens in a direction indicated by the iris perforation. Iridodonesis, racket-shaped pupil, the small end being directed towards the iris perforation. 4. Subcapsular opacity, nonprogressive, but causing marked loss of vision. 5. Normal fundus; in some cases, however, where the lesions are not limited to the soft parts of the face, fundus lesions may also be present. 6. Vision equals 1/20 to 1/50 or less. The last shows that the lesions of the anterior segment are much more prejudicial to the function than those of the posterior segment; in the latter the vision may be equal to 20/20 in spite of marked atrophy and pigmentary lesions in the periphery of the retina.

Synechia. Adhesion of parts; especially, adhesion of the iris to the cornea or to the lens. It is called *anterior synechia* in the first instance; *posterior synechia* in the second. See p. 6649, Vol. IX; p. 3503, Vol. V, and p. 512, Vol. I of this *Encyclopedia.*

Synechia, Annular. CIRCULAR SYNECHIA. Adhesion of the whole rim of the iris to the lens (*posterior annular synechia*) or to the cornea (*anterior annular synechia*).

Synechia, Anterior. Adhesion of the iris to the cornea, which may be total (complete) (*annular*), *partial* or *peripheral.* See **Synechia**; also **Iridotomy**; **Cataract, Senile** and **Cornea, Ulcer of the.**

Synechia, Anterior peripheral. See p. 3503, and **Corelyisis**, p. 3326. Vol. V of this *Encyclopedia.*

In addition to the matter found under various appropriate headings in this work, Hesse (*Klin. Monatsbl. f. Augenheilk.*, March-April, 1914, abs.: *Ann. of Ophthalm.*, p. 351, Apr., 1916) suggests a method of illuminating the eyeball by means of an instrument somewhat sim-

ilar to Sachs' lamp, to prove whether an anterior synechia is present or not, in order to decide on the type of operation to be done in glaucoma. As the light is moved towards the posterior chamber, if an anterior synechia is present the pupil will be illuminated before the ciliary region has been passed, as must be done in the normal eye where the borderline between anterior and posterior chamber is the ciliary body. In a normal eye the pupil becomes illuminated—i. e., red—only after the pencil of light has passed behind the ciliary body. By bringing the light into the equatorial region he was able to demonstrate not only a reddish pupil but a reddish ring one millimeter posterior to the limbus corneæ. This two and one-half millimeter wide ring was separated from the remainder of the posterior chamber by a darker area—i. e., that of the ciliary body.

Synechia, Posterior. Adhesion of the iris to the capsule of the lens, generally as the result of some form of iritis. See p. 496, Vol. I, and p. 6649, Vol. IX of this *Encyclopedia*.

If the *posterior synechia is complete* and adhesions have shut off the anterior from the posterior chamber, an immediate iridectomy should be made. It will give a good result provided the ciliary body and retina are intact. In recurrent iritis, with numerous adhesions, an iridectomy should be made between the attacks and will often prevent recurrences, provided the general system is cared for. If the pupil is blocked by exudation interfering with vision, an optical iridectomy is of value.

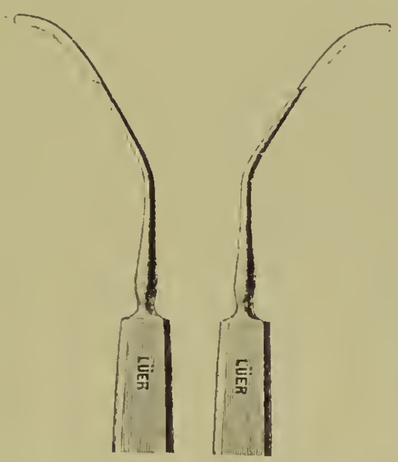
Before resorting to an excision of the iris for extensive adhesions following iritis, the surgeon should determine, as far as possible, the condition of the deep parts of the eye, the acuity of vision, the effect of mydriatics upon the iris, and the condition of this membrane. If the iris is atrophic or the vision is greatly reduced, the effect of an iridectomy will be slight or nil. The excision of an atrophic iris is a difficult matter. If the tension of the eye is subnormal, it is probable that no good will follow the iridectomy. On the other hand, increased tension remaining after recovery from acute iritis renders iridectomy imperative, and here the operation is often followed by brilliant results. When only the pupillary margin is attached, an iridectomy can be made easily; while if the whole iris is bound down to the capsule, the excision is difficult. After completing the operation the surgeon may find that he has removed only the anterior layers of the iris, while the pigment layer remains attached to the capsule. In such cases it is often necessary to extract the lens, together with a large part of the iris, to get results. Even under the most skillful manipulation some of these cases will go to destruction, either by hemorrhage

during or following the operation, by infection, or by iridocyclitis. Where only few posterior synechiæ are present, they do not call for treatment. It has been held that their presence tends to produce relapses; this, however, is doubtful since every ophthalmic surgeon has met with patients presenting extensive posterior synechiæ, who for many years remained free from a second attack of iritis.

The operation for detaching such posterior adhesions (corelysis), so often practised by the older ophthalmologists, is now obsolete.—(J. M. B.)

Synechia, Total. Adhesion of the whole surface of the iris to the cornea or lens.

Synechotome. Synechiotome. A cutting instrument for use in the division of a synechia. See **Corelysis**, where a number of these instruments are depicted.



Abadie's Synechotomes, Right and Left.

Under the present heading some additional knives, etc., are figured. The mode of using the majority is suggested by the cuts. In most cases the introduction of the synechotome is preceded by the use of a keratome.

Desmarres' Synechotome.

The instruments of Bourgeois are modeled after early devices of Jungken, in which each has one cutting and one dull edge and a blunt point. The division of the synechia is carefully and slowly made by a sawing motion.

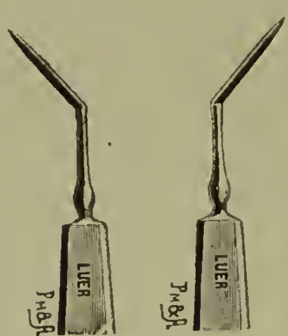
Only the margin of the hook-synechotome (*crochet*) is sharpened.

Bourgeois' Synechotomes, Right and Left.

The Hook Synechotome.
This instrument is made in several sizes.

Lang's Twin Knives for Severing Anterior Synechia.
One is sharp-pointed, the other blunt. See p. 3326, Vol. V of this *Encyclopedia.*

Picoli's Synechotome.



Straub's Knives for Synechotomy, Right and Left.

Ziegler's Iridectomy Knife and Synechotome.

Picoli's *synechiotome* is shown as a fine, sickle-shaped, very sharp-pointed knife that may be passed through the cornea without a previous opening, as in the case of Lang's and Ziegler's knives, thus gaining the advantage of a full anterior chamber in which to manipulate the cutting instrument and sometimes giving a deeper space between the adherent iris and the cornea.

Synechotomy. The operation of cutting or dividing a synechia. See **Synechotome.**

Synergy. Correlated action or coöperation on the part of two or more structures or drugs.

Synergists, Oculomuscular. Those eye muscles that work together for the purposes of binocular vision. See p. 504, Vol. I of this *Encyclopedia.*

Synesthesia, Ocular. Vision in one eye from stimulus applied in the apparatus of the other; or from a more distant centre. See, e. g., *Die Optischen Synasthien,* by E. L. A. Hoffmann, München, 1910.

Synesthete. One who possesses the allied sensations of color-hearing and color-thinking. See, also, **Chromatic audition,** p. 2186, Vol. III of this *Encyclopedia.*

Synizesis. (Obs.) A closure of the pupil, causing loss of vision.

Synococci. A name given by Nicolle and Blaizot to organisms closely allied to gonococci. See **Serology,** near the end of the section.

Synophrys. The condition in which the eyebrows grow together.

Synophthalmia. Having only a single eye,-in the centre of the forehead, as in *cyclopia, arrhinencephalia,* etc. See **Cyclops,** under **Congenital anomalies.**

Synophthalmus. A cyclops.

Syntypic. SYNTYPOUS. Belonging to the same type.

Syphilidophthalmia. Syphilitic ophthalmia.

Syphilis of the eye. SYPHILOPHTHALMIA. OCULAR LUES. This section should be read with other obviously related headings, reference to some of which are made in this text. These are especially **Spirocheta pallida; Chancre of the conjunctiva,** p. 1997; **Chancre of the external eye; Chancre of the lid,** p. 2003, Vol. III; **Choroiditis, Syphilitic,** p. 2158, Vol. III; **Choroiditis disseminata,** p. 2141, Vol. III; **Neosalvarsan,** p. 8304, Vol. XI; **Gumma,** p. 5657, Vol. VII; **Salvarsan** (*arsphenamin*), p. 11502, Vol. XV; **Retina, Syphilis of the,** p. 11323, Vol. XV; **Retinitis, Syphilitic,** p. 11394, Vol. XV; **Keratitis, Interstitial** or **Parenchymatous,** p. 6789, Vol. IX; **Optic atrophy,** p. 688, Vol. I and p. 9059, Vol. XII; **Ophthalmoplegia,** p. 8936, Vol. XII and p. 4006, Vol. VI; **Neurology of the eye,** pages 8353, and 8357,

Vol. XI; also **Wassermann reaction**; as well as **Luetin**, p. 7543, Vol. X, and such captions as **Tabes dorsalis.**

Attention is also drawn to the most recent and most complete work on ocular syphilis, published under the same title as Alexander's early work, **Syphilis und Auge,** 1919, by J. Igersheimer.

Our conception of syphilitic infections has made remarkable progress in recent years. This progress has been classified under four heads by Stephenson, as follows:

1. The discovery by Metchnikoff and Roux in 1903, that syphilis could be inoculated into the preputial fold of the clitoris or eyebrow of the chimpanzee with the production of a chancre and of secondary symptoms and could be transmitted from one chimpanzee to another.

2. The recognition by Schaudinn and Hoffman in 1905, of the bacterium known as *spirocheta pallida* as the cause of the disease.

3. The sero-diagnosis of syphilis introduced by August von Wassermann in 1906, which allows us to recognize the existence of the disease in the patient's blood and to check the results of treatment altogether apart from the clinical manifestations.

4. The discovery by Ehrlich and Hata, in 1909, of an arsenical compound, salvarsan, which, when injected into the veins, usually has a striking and rapid effect upon the clinical manifestations of syphilis. In this connection the more recent discovery by Ehrlich of neo-salvarsan, a formaldehyde compound of salvarsan, must also be mentioned.

The spirocheta pallida has been found in all kinds of lesions of syphilis. With the proper technique it may be easily found in the primary and secondary lesions, in chancres, condylomas, and in large lymph glands. In the gummatous lesions and late manifestations of the disease they are found with difficulty because of the smallness of the number. It has been demonstrated in the primary lesion of the eyelid and conjunctiva; in the conjunctival discharge of a child with congenital syphilis; in a mucous patch of the conjunctiva; in the cornea of infants suffering with keratomalacia; in the aqueous humor withdrawn from the cases of acute irido-cyclitis; and in the cornea of cases of interstitial keratitis.

Santos Fernandez offers a statistical analysis of the incidence of syphilis among cases of ocular disease treated in the Havana clinic during 39 years. Of 50,250 cases of eye disease 16,697 were due to syphilis. Of this number 978 were cases of iritis, 547 were fundus cases, 142 of paralysis and 30 were disease of the lids or of the bones of the orbit. Harman found in 1,100 cases of blindness of children

34 per cent. were due to syphilis. Manson, Mackie and Smith, to ascertain the frequency of syphilis in various ocular conditions, submitted 250 cases to the Wassermann test. Of 63 cases of interstitial keratitis 89 per cent. gave a positive reaction which was marked even though the disease had been long quiescent. Of 50 patients with iritis, or irido-cyclitis, 54 per cent. proved syphilitic. Of three cases of cyclitis all gave negative reactions and in 26 cases of choroiditis only 5 were positive. Three cases of retinitis pigmentosa, 5 of detached retina, 4 of sympathetic ophthalmia gave negative results. Of 14 cases of neuro-retinitis 5 were positive. Among 21 optic atrophies 12 gave a positive reaction, as did 7 out of 13 cases of palsies of the ocular muscles. These writers conclude that outside of ocular injuries, conjunctivitis, cataract, and errors of refraction half of the cases of ocular disease may be due to syphilis.

PRIMARY SYPHILIS OF THE EYE.

The primary lesion of the disease is found in from 4 to 6 per cent. of all cases as extra-genital chancres. This lesion may occur on any exposed surface of the body, and the eye is no exception to the rule. The most frequent ocular chancres are, in order, of the conjunctiva of the lower eyelid; the cul-de-sac; and the lower lid margin. Next in order of frequency comes the inner angle of the eyelids; then the upper lid and cul-de-sac; next the ocular conjunctiva; and least frequent of all the cutaneous surface of the lid.

Etiology. The cause of chancre coming in this situation (about the eye) is direct infection by the spirocheta pallida. The way in which this is caused is usually by the scratch of an infected finger-nail. Cameron reports the case of a nurse who became infected by the scratch of the finger-nail of a child with congenital syphilis. A person with mucous patches about the lips may inoculate any abraded surface or the lid margin. Another way by which the conjunctiva may be infected is in the practice among workmen using the tongue to remove foreign bodies from the eye, and by the practice of using the tongue in the treatment of trachoma. If such persons were suffering with syphilitic lesions of the mouth infection is certain to take place. The infection may be introduced by unclean towels or instruments. Sometimes physicians have been inoculated while treating the throat of a syphilitic, by the patient's saliva being projected by coughing. Jampolsky reported a case of primary infection in a midwife who was infected by receiving in her eye some of the amniotic fluid of a patient she was confining. Antonelli reports the case of a workman who became infected when he washed his eye, which had been injured, with water from a glass of a fellow workman.

Chancre of the conjunctiva has all the appearances and characteristics of a chancre in any other part of the body. If the primary focus of inflammation is formed at the point of infection, there is first a papule which spreads and forms scales in eight or ten days after its appearance. But it may ulcerate and give rise to the secretion of a serous or purulent fluid. Simultaneously the bottom becomes indurated and produces a thick, disk-like deposit in the tissue or a thin parchment-like thickening. Occasionally there is a vesicle that becomes eroded and then an ulcer that throws off but little exudate, but which is indurated at the bottom. In other cases there exists first an ulcer and the induration develops subsequently. As a rule a chancre is not painful; the exception to this is found when it is located on the ocular conjunctiva at the limbus. There is chemosis, lachrymation and a muco-purulent discharge from the ulcer. If situated on the lower palpebral conjunctiva, the lid is everted. Usually there is a keratitis when the lesion is situated at the limbus.

A hard chancre on the conjunctiva is a very malignant looking ulcer. There is early enlargement of the pre-auricular and posterior cervical lymphatic glands if the sore is near the outer angle of the eyelids, but the submaxillary glands are most affected if the chancre is near the inner canthus. The hard induration of the initial lesion is very similar to that of a carcinoma or epithelioma, but it may be distinguished from these growths by the rapidity of its development. It might be mistaken for conjunctivitis, episcleritis, or a phlyctenule. It may be difficult to distinguish it from chancroid; however, the lack of induration with an abundant secretion in which the bacillus of Unna-Ducrey is found, should remove any doubt. We must consider Parinaud's conjunctivitis, scleritis, herpes, tuberculosis and gumma. See **Chancre of the conjunctiva**, p. 1997, Vol. III of this *Encyclopedia*.

The possibility of aborting the disease makes an early diagnosis of vital importance. In the primary stage, at the appearance of the chancre, the evidence is strong to lead us to hope that with salvarsan (arsphenamin), much more can be done than ever has been done before to abort syphilis. When the syphilitic patient is seen before the disease has become generalized, while the spirochetal infection is localized around the initial lesion, and before the Wassermann has become positive, it is possible in many cases to prevent the development of secondaries and hold the Wassermann negative by immediately instituting and vigorously carrying through a course of salvarsan and mercury treatment.

About 40 per cent. of cases of initial lesion, which can be distinguished by demonstration of the spirocheta pallida, show a negative

Wassermann for one or two weeks after the lesion's appearance. In these cases there is a reasonable prospect that syphilis may be aborted. Therefore in external lesions of the eye, sueh as suspeeted chancres or condylomata, mueous patehes of the skin or eonjunctiva, an attempt should always be made to establish the diagnosis by demonstrating the spirocheta pallida. A lesion should never be pronounced negative until repeated examinations have failed to diselose the protozoon.

The technique of Phipps and Glynn for collecting material for the demonstration of the spiroeheta pallida is as follows: The lesion is first eleansed with eotton and then wiped over with wool previously soaked in methyl alcohol. After a few moments the alcohol is wiped away and the elear serum which soon exudes from the suspected sore is smeared on eover glasses and stained. The best reagent to employ for the purpose is Giemsa's fluid by which the spiroehete is stained pink and other spirochetes blue. The method of using Giemsa's stain is as follows: The preparation is fixed by gentle heat and is then stained with azur II eosin. Ten drops of the stain are gently mixed with 10 ee. of tap water, and in aeeordanee with the plan recommended by McDonagh, the smear is covered with the mixture and heated over the flame until vapor rises. It is then left for thirty seeonds, when the fluid is poured off. The proeess is repeated four times. Finally the speeimen is washed in tap water, dried and mounted.

By most writers the method of dark-ground illumination is now regarded as the best for the diseovery of the spirocheta pallida. Roddy suggests the following method of preparing a speeimen of fluid or seraping from the lesion for dark-field illumination: The sore should not be washed or dressed with any antiseptie for at least twenty-four hours. About six hours before obtaining the specimen, the lesion should be washed with physiologie salt solution and eovered with a gauze dressing, moistened with the same solution, which is not to be disturbed until the material for examination is collected. A drop of warm sterile physiologie salt solution is plaeed on the center of each of a number of perfeetly elean slides and a drop of the fluid or serapings to be examined is mixed with it, forming a thin film free from air bubbles and oeeupying the entire space between the slide and the eover glass. The preparations are luted with melted petroleum or paraffin, a drop of immersion oil is placed on the dark-field eondenser and the slide is plaeed on it. Another drop of immersion oil is plaeed on the cover glass and the oil immersion lens brought in contaet with it. (Wright's *Principles of Microscopy.*)

The method of employment is as follows: For low powers without

a condenser, the diaphragm of the microscope must be wide open, and the mirror so tilted that the object is lighted by oblique rays which cannot get directly into the front lens of the objective. With a condenser a central stop diaphragm is used which admits only marginal rays. For high powers, according to one system, very wide apertures are necessary in the condensers. In another method, useful for both high and low powers, an objective of wide aperture and a condenser of moderate aperture are employed. The field is lighted as in ordinary microscopy by a zone of light from the condenser, but with a diaphragm or stop of the right size.

Pathology of syphilis. The initial lesion begins as a papule, in a few days fine scales form on the apex and then the papule breaks down and the ulcer is formed, the edges of the ulcer are raised and irregular. It has a dusky-red appearance. Sometimes the chancre begins as a vesicle which ruptures and forms the ulcer. The induration is caused mainly by an accumulation of small, round cells in the interstices of the connective tissue. Occasionally epitheloid cells are formed and giant cells. In the later stages plasma cells and fibroblasts make their appearance. The vessels of the parts show the changes of endarteritis and periarteritis. Spirochetes invade the walls of the blood vessels but occur chiefly in aggregations around the latter. When this takes place the summit of development is reached, then the greater part of the tissue disintegrates and ulcerates, or becomes absorbed.

Unless complicated with mixed infection, chancre does not do serious damage to the conjunctiva or the eyelid. Under proper treatment this lesion with all accompanying symptoms quickly disappears and leaves a small scar only.

When the diagnosis is made within the first two weeks of the appearance of the chancre it is probably possible not only to cause the disappearance of the local inflammation but to abort the disease by the immediate use of salvarsan and mercury. Locally the indications are for cleanliness by the use of boric acid and irrigations and the use of lotio nigra.

Chancre of the eyelid. The lower lid is most frequently involved and usually at the lid margin the sore presents the same characteristics as chancre in other parts of the body, a slightly elevated, dusky-red base; indurated, furfuraceous, or slightly ulcerated apex. In some cases the ulcer is deep, the edges raised and irregular. The preauricular and submaxillary glands are enlarged.

SECONDARY AND TERTIARY LESIONS OF THE LID AND CONJUNCTIVA.

The papular syphilide and the copper-colored patches are observed as secondary manifestations. They do not differ from the same manifestations on the skin and on other parts of the body. Mucous patches may be found on the conjunctiva. They resemble the same conditions on other mucous membranes.

Papillary syphilides of the conjunctiva are not common. They accompany papillary syphilides on the face and lids. Copper-colored spots have been observed accompanying the same condition of the skin. Mucous patches occur in the secondary and early tertiary stages. They are most commonly seen at the margin of the lid extending to the tarsal conjunctiva but may occur on any part of the membrane. They are slightly elevated, with an even, grayish, furfuraceous surface. (Weeks.)

Rosenbaum observed ulceration of the eyelids of fourteen months duration. The punched-out ulcers occupied the ciliary margins. The cilia were destroyed. The Wassermann was positive.

Gummata of the conjunctiva are rare, and, according to de Beck, are usually developed in the ridge where the conjunctiva passes to the cornea, but may occur on other parts of the mucous membrane. They form rounded tumors the size of a split-pea. They are smooth and firm, present a light-pink color and, when uncomplicated, cause no pain. They grow rapidly and quickly disappear under proper local and general treatment. In the absence of a specific history they may be mistaken for cyst, abscess or chalazion.

Gumma of the lids is probably the most frequent of the syphilitic palpebral diseases. The lid becomes swollen and tense. Ulceration follows, due to the proliferation of the endothelium of blood vessels, together with infiltration of all three coats with small, round cells. Later the vessel wall is narrowed or even excluded by the irregular thickening of the intima. The necrosis of a gumma is due largely to this luetic endarteritis, the ulcer having an irregular, eroded, punched-out appearance. Its floor is covered with dirty-yellow or gray débris and if unchecked there may be extensive destruction of the tissues. The syphilitic ulcer presents an infiltrated base but not the parchment-like, indurated base of chancre (de Beck).

Gumma must be differentiated from rodent ulcer; the latter occurs in elderly people and its growth is very slow. Tubercular ulcers of the eyelid have their origin in tuberculosis of the conjunctiva. They are exceedingly rare. There is a profuse, purulent discharge and early involvement of the cornea (Ball).

A typical gumma has three zones, a caseous centre, a zone of surrounding cicatricial tissue, and a zone of granulation tissue in which giant cells are by no means infrequent. Side by side with the foregoing changes the blood vessels show proliferation of the endothelium, together with infiltration of all three coats with small, round cells. Later the vessel wall becomes narrowed, distorted, or even occluded by the irregular thickening of the intima. The necrosis of gummata which furnishes us with one of their most characteristic clinical features, is largely due to the syphilitic endarteritis. See **Gumma**, p. 5657, Vol. VII of this *Encyclopedia*.

Syphilitic tarsitis is a chronic, often uniform thickening of the tarsus. The upper lids are chiefly affected, and the disease is bilateral. There is no pain accompanying the thickening, which advances extremely slowly. Tarsitis is a manifestation of tertiary syphilis. It is sometimes observed in hereditary syphilis. Feuer (*Ung. Med. Presse*, p. 20, 1898) mentions a case of congenital tarsitis occurring in an infant of three months. The convex margin of the lid on the left side (the side more affected) reached the margin of the orbit. The eyelids could be opened very little. There were ulcers on the lids and enlarged cervical lymph glands. Autopsy showed congenital syphilis.

The tarsus is much enlarged so that the lids cannot be everted, and is of cartilaginous hardness. When cut it does not bleed. Both lids of the same eye may be affected. Histologically these cases have been examined by Rogman, Reiner and Basso, who have found hyaline degeneration of the fibrous tissue with few nucleated cells. Near the surface the tissue was infiltrated with round cells and partially replaced by granulation tissue with new-formed connective tissue. In one case there were calcareous deposits (Basso). The vessels, especially the small arteries, showed hyaline degeneration, atrophy of the media, slight thickening of the adventitia and enormous proliferation of the intima amounting often to endarteritis obliterans. The veins suffered least. In one case of seven years' duration, the conjunctival epithelium resembled epidermis. In another of eight years' duration, the conjunctiva bulbi was erotic (Parsons).

All the manifestations of syphilis of the lid require vigorous, systemic, antisyphilitic treatment. Locally inunctions of mercurial ointment may be employed in the non-ulcerative forms. In ulcerative forms, cleansing with a solution of bichloride of mercury, 1 to 2,000, and the use of calomel should be protracted. In tarsitis spontaneous recession of the process may occur, leaving the tarsus in an atrophic condition, thinner even than in the normal state (Weeks). Tarsitis is

characterized by a great thickening of the lid margin, often producing considerable deformity. In tarsitis of the lower lid ectropion is not uncommon.

SYPHILIS OF THE LACHRYMAL APPARATUS.

Luetic stenosis of the lachrymal duct. Stenosis of the lachrymal duct may be partial or complete. It is due in a vast majority of cases to a thickening of the mucous membrane of the canal, consequent on the extension of disease from the nasal cavity. Atrophic rhinitis or periostitis, which occurs most frequently in children with inherited syphilis, also in syphilitic adults with caries of the bony canal, produces stenosis of the lachrymal duct. Hereditary lues plays an important rôle in affections of the lachrymal passages in children between the ages of two and fourteen years. Igersheimer reported 20 cases in which the nose was examined by a rhinologist and in which the Wassermann reaction was positive. The affections consisted of dacryostenosis with epiphora, dacryocystitis with blennorrhea, lachrymal fistula, dacryocystitis and phlegmon of the lachrymal sac. Fifty per cent. of all affections of the lachrymal passages in children were of luetic origin.

Antonelli found an exostosis of the free borders of the nasal base as the most frequent stigma in congenital lues.

Epiphora is the most common *symptom* of syphilitic lachrymal stenosis. Tears are abundant, particularly when the secretion is increased by emotion, exposure to cold, wind, rain, snow or from whatever cause. The lachrymal sac is sometimes distended and pressure on it causes an escape of lachrymal fluid into the conjunctival sac; and in cases of partial stenosis, into the lachrymal duct. The superabundance of tears in the conjunctival sac causes more or less hyperemia of the conjunctiva. Stenosis of the lachrymal duct may lead to mucocele, subacute or chronic dacryocystitis, acute dacryocystitis and phlegmon of the sac. See, also, p. 3709, Vol. V of this *Encyclopedia.*

Syphilis of the lachrymal gland is relatively rare. However, gummatous infiltration of the gland has been observed. Anagarsa reported a case of initial lesion of the lachrymal gland in which enlargement of the gland was regarded as tuberculous and the gland was extirpated. The subsequent history of the case determined the syphilitic character of the growth. Guilini reported two cases of lues of the lachrymal gland; both gave a positive Wassermann. One patient with acquired syphilis had an enormous swelling of the glands, edema of the eyelids, amaurosis, conjunctival injection and exophthalmos. In any case of enlargement of the lachrymal gland in which the diagnosis

is not known, the therapeutic test should be used. See **Dacryoadenitis,** p. 3708, Vol. V of this *Encyclopedia.*

OCULAR FINDINGS IN HEREDITARY SYPHILIS.

Stieren says that 50 per cent. of syphilitic fetuses are stillborn, and of the remainder 80 per cent. develop ocular disease. Tarsitis and dacryocystitis secondary to syphilitic rhinitis are seen. He has met with a case of blepharitis which he believes was due to syphilis.

Parenchymatous keratitis is not pathognomonic of inherited lues, for it has been noted in acquired syphilis, tuberculosis, rheumatism, gout, influenza and uterine affections. The following complications may be met with, viz., irido-choroiditis and iritis, lens opacities, glaucoma, bullous keratitis and keratomalacia.

Iritis is rather uncommon. It may occur quite early, even before birth. On the other hand it may appear much later in life, between the ages of 10 and 20 years, usually affecting but one eye. It presents the following varieties: The serous form, the gummatous form and a form mixed with keratitis.

Hereditary retino-choroidal alterations. Choroiditis is seldom acute but nearly always prenatal. Stieren adopts Huguenin's classification:—In the light form there are scattered, small, reddish-yellow spots, with fine, pigment points, usually limited to the periphery; the disc may be pale; visual field slightly contracted; visual acuity never quite normal; little tendency to progress.

Then we see pronounced pigmented foci, isolated or conglomerate, preferably peripheral, visual acuity unaffected. This type is often found after sudsidence of interstitial keratitis and is usually stationary.

The third type presents lesions of round or oval light-yellow areas with masses of pigment upon their borders, especially peripheral but not limited there; visual field contracted. Prognosis less favorable as it may spread backwards to the posterior pole. This is the severest of all. There is disappearance of pigment in places and hyperplasia in others, the macular and peripapillary regions being affected. The periphery is free from pigment. In addition there are round, yellowish foci, and the whole fundus presents a grayish, slate-colored tinge. The discs are pale and the vessels contracted. It may be unilateral but is usually bilateral. See, also, p. 2158, Vol. III of this *Encyclopedia.*

THE WASSERMANN REACTION AND THE LUETIN TEST IN OPHTHALMOLOGY.

The application of the Wassermann reaction and the luetin test in ophthalmology has been studied by Machie and Manson. In 250 cases,

NEURO-RETINITIS SYPHILITICA ET PAPILLEDEMA (WURDEMANN)

1 EARLY STAGE. 2. MEDIUM, WITH EDEMA. 3. MEDIUM. 4. ADVANCED. 5. INTENSE. 6. CHOKED DISK.

including 29 forms of ocular disease, they obtained 125 positive Wassermann reactions, 122 negative and 3 doubtful. Different conditions varied greatly as to the relative frequency of positive reactions, from 56 positive to 7 negative in interstitial keratitis, and 13 positive to 8 negative in optic atrophy; to 1 positive and 8 negative in strumous keratitis. In iritis and irido-cyclitis there were 27 positive to 22 negative and 1 doubtful. In choroiditis and choroidal atrophy, there were 5 positive to 20 negative and one doubtful; and in retinitis pigmentosa all were negative.

Comparisons of the Wassermann reaction and the luetin test were made in 50 cases, representing 12 forms of ocular disease. In 35 of these Wassermann was negative, and the luetin positive in 19 and negative in 16 of them. In two the Wasserman was doubtful, but the luetin test was positive in both. Of 13 positive Wassermann 4 gave positive luetin reactions and none negative. In five cases of interstitial keratitis the one which gave a negative Wassermann was positive to luetin, and of the four which gave positive Wassermann, 3 gave negative luetin and 1 positive. These authors are convinced that the luetin reaction presents a characteristic and definite specific cutaneous reaction to products of the spirochete. They believe its value has been demonstrated as a supplementary test to the Wassermann. In the class of cases where the serum reaction is negative the cutaneous is likely to yield a definite positive result.

Cohen in investigating the Wassermann reaction and luetin test found the latter to agree with the clinical evidence and the Wassermann in 76⅔ per cent. of cases.

The value of Noguchi's luetin test for syphilis has been studied by Wolff and Zeemann in 39 cases, by comparison of the results with those obtained by the Wassermann reaction. They conclude that a positive luetin test indicates syphilis with great probability, but that it has hardly been perfected for clinical use. See, also, p. 7543, Vol. X of this *Encyclopedia*.

SYPHILITIC DISEASE OF THE CORNEA.

To the matter found on p. 6789, Vol. IX of this *Encyclopedia* it may be added here that *luetic, interstitial* or *parenchymatous keratitis* is characterized by the development of a diffuse, inflammatory, infiltration of the substantia propria of the cornea, attended with symptoms of irritation. The infiltration may proceed (a) from the periphery of the cornea, or (b) be primarily dense at the centre of the cornea, spreading toward the periphery. It may involve a part or the whole of the cornea. Both eyes are usually attacked, but often not simultaneously.

When advancing from the periphery, the free border of the infiltration is irregular and less dense than at the margin of the cornea. If examined by a lens, the infiltration will be found to be uneven in density, frequently being made up of a number of foci. Thickening of the conjunctiva at the sclero-corneal junction accompanies the process, the limbus is deeply congested, presenting a bright-red border apparently advancing on the cornea a short distance. The extension of the vessels of the conjunctiva on the cornea is limited by a sharp line of demarcation and seldom exceeds more than one, or one-and-one-half millimeters. Soon vessels from the margin of the cornea make their appearance in the parenchyma of the cornea, extending into the infiltrated area. The infiltration advances toward the center of the cornea.

The second mode of onset is that in which the opacity first manifests itself in the center of the cornea. The infiltration occurs in numerous foci, gradually spreading until the greater part of the cornea is involved. The vessels of the limbus throughout the whole periphery of the cornea are somewhat injected and swollen, an epaulet-like swelling of the limbus; but the important vascularity occurs in the deep layers of the cornea, advancing from the periphery. The branching of the vessels has a broom-like appearance. In both forms of onset the surface of the cornea becomes somewhat roughened, and may have the appearance of ground-glass. Vision is impaired in proportion to the density of the infiltration. The infiltration advances rapidly in some cases, involving the entire corneal tissue in from two to four weeks. In others the advance is much less rapid, the height of the affection being reached only after two or three months.

McDannald reported a case of hereditary syphilis in twins. In one there was interstitial keratitis with a positive Wassermann, whereas in the other there was a negative Wassermann and no eye symptoms.

The chief *causes of interstitial keratitis* are hereditary and acquired syphilis. When due to hereditary syphilis it may affect individuals between the ages of five and forty-five years. It occurs most frequently in children between the ages of seven and fifteen years. The sexes are affected with about equal frequency. Some writers think it more frequent in females than in males. Recovery is gradual, beginning at the periphery where the cornea first becomes transparent again, while at the same time the vessels grow constantly fewer. The center of the cornea remains opaque the longest, but finally clears up until there is a faint cloudiness which causes but little impairment of vision. This cloudiness and a few minute vessels, which are visible only with a high magnifying glass, can still be made out years after-

wards and are certain signs of the previous existence of a parenchymatous keratitis.

Parenchymatous keratitis is accompanied by irritative symptoms of inflammation such as pain, photophobia and lachrymation. These symptoms depend for their degree of severity upon the amount of vascularization that is associated with the keratitis. Keratitis is almost always complicated with inflammation of the uveal tract. In the lightest cases there is merely hyperemia of the iris. In severe cases there is irido-cyclitis which may lead to the formation of posterior synechiæ, the formation of deposits upon the posterior surface of the cornea, and seclusion and occlusion of the pupil. Parenchymatous keratitis generally attacks both eyes, and more frequently both in succession than both at once. Sometimes there is an interval of several years between the infections of the two eyes.

The upper jaws are flat and the bridge of the nose low, or actually sunken in—the saddle-nose. The frontal eminences are prominent, the cornea has often the shape of a vertical ellipse. The incisor teeth are abnormally shaped so that instead of a straight edge they show a semilunar notch (Hutchinson's teeth). The change is present only in the teeth of the second dentition and in the upper central incisors. These teeth are often stunted and small, smaller at the incisal edge than at the base.

Charles, in a study of the teeth in the congenitally blind, finds that when one of the central incisors appears notched and the other normal, transillumination, by placing the light in the mouth behind them, may bring out defects in the enamel of the apparently normal teeth. Occasionally when there is no notching of either tooth that would otherwise have been called Hutchinson teeth, they may show areas of deficient enamel, or may be traversed by alternating lines of normal and deficient enamel. In one of these cases, a boy ten years old, congenitally blind, with one notched tooth, there was found to be other defects. His blood was Wassermann positive and his spinal fluid negative.

At the angles of the mouth we may find fine cicatrices, the relics of former rhagades. These cicatrices may be found in the mouth and the pharynx. Enlarged lymph-glands may be found upon the neck. They are small, hard, painless and with no tendency to ulceration. Swelling of the periosteum may be easily found upon the anterior border of the tibia. There is frequently some loss of hearing.

The experimental studies by de Schweinitz and Woods with trypanosomes injected intra-peritoneally in dogs showed two types of ocular lesions. One, simple clouding of the cornea; the other a severe

form with exudations and hemorrhages in the anterior chamber. The cornea became opaque. Trypanosomes were found in the aqueous of all eyes showing lesions. The authors concluded from their experiments that there was an acute invasion of the tissue by the parasite. Pathologically the corneal lesions were those of an interstitial keratitis.

Stargardt found that blood containing trypanosomes injected into the limbus, aqueous, or vitreous of rabbits or guinea pigs, gave rise in many instances to interstitial keratitis, and a similar result followed the injection of pure trypanosomes. On the contrary, no inflammation of the cornea followed the injection of the toxins of trypanosomes or the dead trypanosomes themselves. The inference is that interstitial keratitis is due to the actual presence of spirochetes in the cornea.

Levaditi and Yamanouchi have studied the incubation of syphilis in the cornea of the rabbit. They find that in the anterior chamber the treponema multiplies slowly, but where it gains access to endothelial or epithelial cells it multiplies more rapidly. The organism becomes numerous in the cornea long before the signs of keratitis are visible.

The corneal changes in parenchymatous keratitis are due to the presence in the cornea of spirochetes. In the fetus, the newborn and in animals, the keratitis is directly due to the action of the spirochete: whereas in adults, there must be taken into account, in addition, a special altered reaction capacity of corneal tissue. Spirochete products from other parts of the body may also contribute to the development of the affection. Igersheimer thinks that in syphilitic infants there are spirochetes even in the healthy cornea, that these perish but leave an anaphylactic condition against the metabolic products of the spirochete. If afterwards spirochetes from other parts of the body become active and flood the circulatory system with their toxic products the cornea which is over-sensitized becomes inflamed.

The histological changes found in interstitial keratitis are essentially of a gummatous character. Examined microscopically there is an infiltration of the deeper layers of the cornea with round cells, and along with them giant and endothelioid cells. The corneal lamellæ may be separated by these cellular infiltrations. Foci of caseation may form in the gummatous nodules. There may be edema of the corneal epithelium and of the substantia propria. The corneal process often resolves to a greater or less extent, but it may break down into an ulcer or give rise to a bleb, or produce changes in the curvature of the cornea, or even give rise to staphyloma.

The uvea is practically always implicated in parenchymatous keratitis, but is not equally involved in all cases. Minute deposits on

Descemet's membrane are seen on careful examination of the cornea, while posterior synechiæ and foci of choroiditis are found as the opacity clears. The anterior chamber may be deeper than usual, caused by increased accumulation of aqueous due to the irritated state of the uvea and altered conditions of the filtration angle.

Suganuma found general atrophy of the epithelial layer near the limbus; a subepithelial inclusion of a pannus tissue; in the parenchyma a dilation of the lymph spaces; increase and necrosis of the corneal bodies; increase of the wandering cells; infiltration by white blood cells; coagulation and necrosis of the lamellæ.

Descemet's membrane is well preserved, although the endothelial cells are lacking in the central area. At the root of the iris and in the ciliary projections are accumulations of cell infiltrates, the vessels of this region being partially obliterated. In the superficial layers of the sclera is a cellular infiltration, and the marginal vessels of the cornea show an increase in the endothelial cells and collections of white blood cells. The author believes that the disease can be traced to a syphilotoxic influence which first develops its effect on the corneal bodies within the corneal parenchyma, followed by an increase and eventual necrosis of these cells.

Suker believes there must be two types of this disease, one in which the cornea shows small, infiltrative spots with radiations emanating from these areas; in the other he believes the principal feature is corneal striations. The first he believes to be a direct expression of the activity of the spirochete in the cornea, the process being not so deep, and more responsive to treatment. The second type, he thinks, must be due to a syphilitic toxin, which lies much deeper and consequently is not so amenable to antiluctic treatment but does respond some to tonic treatment.

Stähli (*Arch f. Aug.*, p. 13, Vol. 74) gives the histo-pathology of the eye of a boy with hereditary lues. The choroid contained very small, fibrous foci with a few round cells and accumulations of pigment. The retina was atrophic and edematous and the vessel-walls were infiltrated with round cells and pigment. The rods and cones were missing at the places of emigrated pigment. The optic nerve was atrophic. The substantia propria had localized accumulations of round cells and new-formed connective tissue cells, especially toward the posterior strata. There were deposits in Descemet's membrane.

Stephenson calls attention to the form of parenchymatous keratitis in which the ordinary salmon patch is replaced by a somewhat prominent, fleshy-looking mass, at first resembling nothing so much as a neoplasm. Other parts of the cornea present the ordinary appearances of this form of keratitis. Gradually the fleshy-looking mass loses its

prominence and sinks to the general corneal level. It is not followed by local bulging. In other respects such cases run the ordinary course of interstitial keratitis.

Derby reports on the end results of parenchymatous keratitis in a series of 96 cases, in two of which but one eye was affected. In 168 eyes there was more or less corneal opacity; in 14 eyes none could be seen. In 171 eyes vessels were found in the cornea; in 15 eyes they were absent. Posterior synechiæ were noted in 62 eyes. In 4 eyes there was slight opacification of the lens. In 11 eyes vitreous opacities were noticed, but in 38 the corneal scars, or a permanently contracted pupil, made it impossible to examine the deeper structures. Of 148 eyes examined for changes in the choroid and retina 81 showed lesions, mostly rounded, disseminated spots, situated in the equatorial region. The vision present was ascertained in 161 eyes to be as follows:

Number of eyes.	Vision.
32	10/10
17	7/10
18	5/10
13	4/10
25	3/10
14	2/10
17	1/10
25	less than 1/10

In some cases vision may improve as the child grows older but in others it may be further damaged by recurrences. In 37 cases carefully investigated with reference to recurrences, Derby found positive evidence of recurrences in 14 and probably in 3 others.

Local treatment of luetic interstitial keratitis consists in protecting the eyes from the light and by instilling atropin. Often it is impossible to obtain an adequate dilation of the pupil with atropin. Probably the atropin does not diffuse through the inflamed cornea to the same extent as it does through a sound one. Moist, hot compresses often relieve the symptoms of irritation. Dionin acts favorably on the photophobia and the pain. When the opacity begins to recede dionin should be employed, or calomel or yellow oxide of mercury be dusted into the eye. The aim is to get as clear a cornea as possible.

In the *general treatment* of the disease arsphenamin may be combined with calomel $\frac{1}{10}$ gr. four times a day. Fresh air, exercise and good food should be provided. In the lighter cases we may confine ourselves to simple tonic treatment, with the employment of remedies containing iodin, syrup of iodide of iron, cod liver oil with iodin.

Fradkine advises giving small doses of salvarsan every 48 hours in

order to obtain continued action on the cornea. Blepharospasm, photophobia and excessive vascularization are more favorably influenced by salvarsan than by any other drug.

Waldman used diathermia in interstitial keratitis with excellent results.

Koenig has reported three cases cured with salvarsan, improvement being rapid in body as well as in the eye. Hicks reports five cases treated with ½ to ⅕ gr. of mercury bichloride dissolved in 20 cc. of sterile normal salt solution and injected intravenously every four days.

Igersheimer found neo-salvarsan most effective in interstitial keratitis. Rosenmeyer has used it locally for the condition, which had resisted previous specific treatment. The process was promptly checked and gradual clearing up of the cornea followed.

SYPHILIS OF THE SCLERA.

Syphilis of the sclera manifests itself in the form of *gumma* (see p. 5658, Vol. VII of this *Encyclopedia*), usually affecting the anterior segment of the tunic. Cases are on record in which the posterior portion of the sclera has been the seat of a gummatous mass. When gumma of the sclera occurs in a visible portion it presents itself first as a small nodule. Its growth in size is quite rapid. The base of the nodule is a deep-red and the congestion extends into the surrounding tissue. The apex of the nodule is of a yellowish-pink hue and the base is circular. It may reach a diameter of more than a centimeter. Ulceration takes place at the apex, due to the breaking down of the tissue, and destruction of the eye may follow.

Diagnosis of scleral syphilis. In this situation the gummatous tumor is rather firm in consistence. It may be mistaken for sarcoma. Histologically the cells may resemble those of sarcomatous tissue, but sarcoma of the sclera as a primary growth is very rare. The history, combined with modern laboratory methods of investigation, ought to clear the diagnosis.

The tissue of the sclera is involved by small infiltrations, the fibres of the sclera are pressed apart, and some disappear. If the scleral tissue has been destroyed, as the process subsides, it is partly replaced by scar tissue.

Under vigorous antisyphilitic treatment gumma of the sclera quickly disappears. If the deeper tissues of the globe are not involved no trace of the tumor is left.

LUETIC DISEASES OF THE IRIS AND CILIARY BODY.

Syphilitic iritis and irido-cyclitis. In this connection the various **Iritis** captions (see p. 6652, Vol. IX) should be consulted.

A great number of cases of iritis are due to syphilis, either inherited or acquired. The older writers place the percentage above fifty. Mauthner puts the percentage between sixty and seventy-five; Acosta, fifty-two; Santos Fernandez out of 1697 cases of ocular lues, found 978 were of iritis, the percentage of luctic iritis was 54.79. Out of 100 successive cases of iritis studied by Brown and Irons, there were only 23 in which syphilis was the cause of iritis, and 16 others due to other causes in which syphilitic infection had occurred, making a total of thirty-nine patients in whom syphilis had to be seriously considered in the diagnosis. This leaves 61 cases in which a searching examination failed to reveal any evidence of past or present syphilitic infection, and in which, therefore, the iritis could not be reasonably thought to be due to syphilis. So far as one may draw conclusions from the number of cases it would seem that the widely accepted statement that 50 per cent. or more of iritis is due to syphilis would have to be revised. (*Ophthal. Year Book,* p. 141, Vol. 13.)

Reber studied 15 cases of primary acute iritis, in every one of which the complement fixation tests were made, with the result that 5 cases, or 33 per cent., were certainly syphilitic and 14 per cent. probably syphilitic. These percentages also take into account the clinical aspect of the eyes and the history of the case.

Santos Fernandez describes 19 cases of *condyloma of the iris.* The upper part of the anterior surface of the iris was occupied three times, the major vascular circle of the iris four, and the pupillary and the ciliary borders of the iris at the same time, once, while five times the growth was situated between the pupillary and ciliary borders of the iris. All the cases were in men. In four cases the patients did not know they had contracted syphilis, not having observed any chancre. In one patient the condyloma appeared one month after the chancre, in one, two months, and in others respectively, 2, 4, and 12 months after. In one 18 months had elapsed, and in others 2, 3. and 4 years respectively. Risley reports a case of syphilitic iritis in which, during the convalescence, there appeared two white dots in Descemet's membrane, circular in form and not more than one-half mm. in diameter. He does not remember having seen such a deposit in the presence of any form of uveal disease. Wernicke carefully examined a large series of tabetic patients as to signs of previous specific iritis or irido-cyclitis, without finding any.

Few, if any, inflammations of the iris are strictly confined to that part of the uveal tract. The anatomical relation between the iris, ciliary body, choroid and the tissues of the filtration angle are so close

that all are more or less involved in any inflammatory process of one of them.

Syphilitic iritis belongs in the group of symptomatic inflammations caused by disease of other parts of the eye, or other parts of the body. Syphilitic iritis has certain conditions which are common to all classes of iritis: 1. Pericorneal injection. Except in the quiet iritis of Hutchinson, there is deep injection. The color is darker than a conjunctival injection and is not so uniform, as a rule, as the latter. Occasionally the congestion is so pronounced that the circumcorneal zone cannot be distinguished. It consists in an injection of the muscular branches of the anterior ciliary arteries. 2. Turbidity of the aqueous. This is due to the exudation of serum and fibrin-forming elements from the vessels of the iris and ciliary body and the glands of Treacher Collins. 3. Change of color. Partly due to the turbidity of the aqueous, the congestion of the iris and the presence of exudates in or on the iris. 4. Impairment of mobility; a sluggish pupillary reflex. 5. Impairment of vision. Due to turbidity of the aqueous. 6. Miosis. The pupil is contracted in all cases of iritis. 7. Pain. The pain is referable to the eye and the side of the head corresponding to the eye affected and is worse at night. 8. Photophobia and lachrymation. This varies in degree. 9. Tenderness of the globe. Not always present. 10. Tension. The tension of the eye in iritis is usually normal, sometimes increased.

Syphilitic iritis presents no appearances in the iris itself that are pathognomonic of syphilis. There are two forms of iritis that are peculiar to syphilis, namely, papillary iritis and gummatous iritis.

Papillary iritis resembles plastic iritis. It is identical with this form of the disease with the addition of minute nodules of a dusky-red hue which appear in the iris and are confined to the pupillary zone. The papules originate in tissue-bearing capillaries, are devoid of large blood vessels and resemble the papillary syphilides of the skin. They occur contemporaneously with the skin eruption in many cases. One or more nodules may be present. In the majority of cases the number is more than one. The entire pupillary zone may be crowded with them to such an extent that they appear to coalesce. Wernicke examined anatomically an eye affected with papulous iritis of almost certain syphilitic nature, and found granulation tissue originating from the pigment epithelium encircling the pupil.

The symptoms are the same as already described under symptoms common to all forms of iritis. They vary in degree of severity. The papules appear in from three to four days after the onset of the

disease. They persist or disappear rapidly, depending on the rapidity by which the system is brought under the influence of specific remedies. This form of iritis is always binocular. It may appear in from six weeks to two years after the initial lesion.

Papillary iritis may be confounded with miliary tuberculosis of the iris and with iritis nodosa. If it is remembered that the nodules occurring in these two diseases are not confined to the pupillary zone and that specific treatment has no effect upon them the diagnosis may readily be made. Papillary iritis is recovered from in five to seven weeks, the papules disappearing without leaving a visible trace. Microscopically minute deposits of scar tissue can be found.

Gummatous iritis is present only as a late manifestation of syphilis. It may occur as a result of inherited syphilis but is more frequently met with as acquired syphilis. In inherited syphilis it may be present in the early years of life; in acquired syphilis it is seldom seen before the twenty-fifth year. Gummatous iritis is usually monocular and appears in the form of a single, isolated growth. Two or more foci may be merged together, forming a lobulated elevation. Gumma of the iris occurs most frequently in the ciliary zone, but it may originate in the pupillary zone. The gummatous mass may extend from the iris to the ciliary body; it more frequently happens that the original develops in the ciliary body and advances into the iris.

The *symptoms of gummatous iritis* are characterized by the development of a nodular mass having a pale, yellowish-pink apex and a dusky-red base. The congested area at the base merges quickly into the iris that is more or less normal. Fibrinous exudation occurs which unites the iris to the capsule of the lens. The gumma develops rather rapidly, the tumor appearing in two or three days after the appearance of the first symptoms, and advances rapidly to full size. The pain is sometimes excruciating; often, however, it is not severe.

Syphilitic iritis originates as a local perivasculitis with small, round-cell infiltration. In the sero-plastic form an infiltration of small cells is found around the blood vessels of the iris, the ciliary body and the vessels of the choroid. Perivascular infiltration of small, round-like cells is very pronounced in plastic iritis due to syphilis. In the cases of papillary iritis, collections of small cells occur, forming the nodules.

In gumma of the iris the mass is made up of small, round-cells and inflammatory tissue, rarely a few giant cells are present. The accumulation of small cells is very great. Necrosis or caseation begins in the center of the mass. When the tumor subsides a scar is left in the tissue of the iris.

Sero-fibrinous iritis presents the symptoms common to all forms of iritis, also punctate masses of fibrin and small cells become deposited on the posterior surface of the cornea, often in pyramidal form, and on the surface of the iris and anterior portion of the lens capsule.

Plastic iritis is characterized by the development of a plastic exudation having a decided tendency to unite the posterior surface of the iris at its margin to the capsule of the crystaline lens, and to the blocking of the pupil.

Prélat reported a case of irido-cyclitis occurring in a man three days after receiving his second dose of antityphoid vaccine. The first dose was given two weeks previously. Following the second injection the patient complained of a severe photophobia and pain in the eyelids and eyes. The bulbar conjunctiva of both eyes was intensely injected, the irides dull and infiltrated, the pupils contracted and did not react. A thick exudate was present in the lower portion of the anterior chamber. In the right eye posterior synechia was present and in about eleven hours after the onset the pupil became deformed. Twelve days later the vascular reaction and pain had increased. A Wassermann test was strongly positive. In both irides several condylomas, the majority located near the root of the iris, were seen. There was a keratitis punctata. With intramuscular injections of the iodide of mercury the condition improved and the condylomata reabsorbed. The exudate in the anterior chamber remained, especially in the left eye where it resulted in a seclusio pupillæ. The author was unable to determine whether the acute attack was precipitated by the antityphoid inoculation, or simply was a coincidence in a syphilitic process that was about to manifest itself as an irido-cyclitis. (*Arch. d'Opht.*, Vol. 35, p. 742.)

Atropin is the most important remedy in iritis. In contracting the iris it counteracts the hyperemia by paralyzing the sphincter, it puts the iris at rest, and it may rupture posterior synechiæ. When the iris does not contract easily, due to the inflammation, atropin should be used several times a day, and if this does not produce dilation a small granule of solid atropin should be placed in the conjunctival sac. In cases of irido-cyclitis in which the ciliary body is particularly prominent, atropin may not be well borne. Hot compresses afford great relief of pain. Dionin introduced into the conjunctival sac in powder or in 5 per cent. solution exerts a favorable influence. The application of a number of leeches to the temple will diminish the inflammatory symptoms in severe cases. The constitutional treatment consists in getting the patient under the influence of mercury, the iodide of

potassium and salvarsan. Mercury should be given until the point of saturation is reached; inunctions of ½ dram daily is the best method of administration. (See Vol. IX of this *Encyclopedia,* under **Iritis**.) The eyes should be protected from the light by having the patient wear dark goggles.

Lamb has employed subconjunctival injections of salvarsanized serum, which was obtained sometimes from the patients themselves and sometimes from others undergoing treatment by injections of salvarsan; but always human serum. He mentions especially a case in which posterior synechiæ, previously resistant, rapidly cleared up, as did also a plastic irido-cyclitis. Severe interstitial keratitis was cured in three and one-half months with almost invisible scars. In all cases but those of optic atrophy there was a decided benefit.

Piccillo reported two cases of gumma of the iris and ciliary body in which mercury and potassium iodide had been used without benefit. Rapid improvement followed intra-muscular injections of salvarsan. Black reports a case of syphilitic iritis which made rapid improvement under neo-salvarsan.

Strickler has reported a case of irido-cyclitis in a woman of 25 years with (positive Wassermann and von Pirquet) root abscesses of the right upper bicuspids and molars; their removal and antispecific treatment had no effect. The catheterized urine was loaded with staphylococci, pneumococci and colon bacilli. A marked leucorrhea was found but no gonococci. Treatment was directed to the bladder and vaginal disease, together with potassium iodide. She made definite improvement in every way.

de Schweinitz found paracentesis of the anterior chamber of service as a means of combating intraocular tension during the course of uveitis.

SYPHILIS OF THE CILIARY BODY.

The *ciliary body* may be the seat of syphilitic manifestations in the second and third stage of syphilis. The localized lesions are gummata and tubercular syphilides peculiar to the early and advanced state respectively.

Gumma of the ciliary body is not common. It develops rapidly, reaching an appreciable size in three to five days. It is accompanied by severe ciliary neuralgic pains and sero-purulent exudation of greater or less amount according to the activity of the process. The vision is rapidly reduced. The iris may be but slightly involved but if a gumma is located well forward, congestion of the iris will be present; the cornea becomes hazy and the anterior chamber deep and

hypopyon will often be present. The tension is increased and considerable constitutional disturbances are present. The affection is usually monocular and is seen in subjects with acquired syphilis much more often than in those with the inherited disease. Staphylomata may develop in the ciliary region.

Diagnosis. The pupil should be well dilated if possible, thus affording an opportunity to detect the presence of a tumor projecting from the ciliary body. When the gumma can be seen it presents a yellowish-red color at its apex with a dark base, due to the ligament layer which the tumor penetrates. The sudden growth of the mass, with a history of syphilis, will clinch the diagnosis.

The prognosis should be guarded. If treatment fails the eye may become perforated or phthisis bulbi may occur without perforation. The vision as a rule is not restored. Stieren reported one case in which it was restored to 6/8.

Tubercular syphilide of the ciliary body. This growth is much slower in its development and is accompanied by little disturbance of the tissues other than those directly involved. Inherited syphilis furnishes the greatest number of cases of this extremely rare condition. Symptoms are few. There is little pain, slight ciliary injection localized over the site of the growth, some sero-fibrinous exudation, and gradual impairment of the vision.

With the pupil dilated the mass may come into view. It is lobulated and presents a grayish appearance with a slight pinkish flush, difficult to differentiate from tubercle. In some cases a differential diagnosis can only be made from the effect of treatment.

SYPHILITIC DISEASES OF THE LENS.

The lens is probably never directly affected as the result of syphilis, but syphilitic subjects are distinctly more liable to cataract than are unaffected individuals. This is due to the fact that anything interfering with the nutrition of the eye is liable to produce lenticular opacity. Syphilis affects all the tissues of the eye, and especially the uveal tract, of which the ciliary body is the part that furnishes the nutrition. There is little doubt that many of the cases of congenital cataract seen in children, the subjects of inherited syphilis, are indirectly due to the disease, while it is not at all difficult to imagine a senile cataract developing as the result of malnutrition in an eye which had iritis, choroiditis or other manifestation of syphilis. It is generally accepted that repeated inflammatory attacks of the uveal tract, nearly always syphilitic, may give rise to cataract. Stieren has observed this several times in patients with a clear history of syphilis.

These cases improve under antisyphilitic treatment. See, also, **Cataract, Syphilitic,** p. 1752, Vol. III of this *Encyclopedia.*

SYPHILITIC CHOROIDITIS OR CHORIORETINITIS.

In this disease (see also, p. 2158, Vol. III of this *Encyclopedia*) diffuse cloudiness of the vitreous is present. Shreds of exudate appear in the vitreous and isolated large or small spots of exudation occur in the choroid. The retina appears hazy because of the edema; retinal hemorrhages may occur. There is evidence of perivasculitis of both retinal and choroidal vessels. The vision is frequently greatly diminished; flashes of light, photopsia, micropsia and macropsia may be experienced. Slight injection of the ocular conjunctiva may occur. The exudation into the choroid and retina is sero-plastic. Circular patches of plastic exudation may occur in the choroid. The retinal pigment may disappear over a large area of the fundus, exposing the choroidal vessels.

In *disseminate choroiditis* there is a development of foci of exudation which are spread over a large part of the fundus in the form of circular patches which vary in size, but, as a rule, average in diameter less than that of the optic disk. After a time the exudation becomes absorbed or changed into fixed products and atrophic areas occupy the site of the areas of exudation. Although it may affect but one eye the disease is binocular in most cases.

Two stages are recognized, acute and atrophic. In the early part of the acute stage circular spots of exudation appear in certain parts of the fundus, usually beginning at the periphery, which are paler than the surrounding normal fundus. These spots have not very sharply defined borders. The retina immediately over the masses of the exudation is not elevated, as the ophthalmoscope will show, but there is often an invasion of the retina by the exudate. The spots multiply in number if not interfered with. The areas of exudation are primarily discrete but may eventually coalesce. The greater part of the fundus may be studded over in the course of two or three weeks. Parenchymatous keratitis may occur at the time of the onset of the choroiditis and the choroiditis may not be discovered until the cornea clears up.

In the *atropic stage* the exudation gradually disappears, the spots become paler, the border of the affected areas becomes irregularly pigmented, the pigment being heaped up at different points. Entire absence of pigment has been observed. All degrees of change may occur in all layers of the choroid, from little impairment to complete atrophy with disappearance of all vessels. The pigment changes noted are due to destruction and more or less complete disappearance

of the choroidal and retinal pigment throughout the affected area.

In the acute stage a small-celled infiltration takes place of the choroid at the site of each lesion, accompanied by local congestion of small blood vessels and capillaries and an exudate. Atrophy follows the disappearance of the exudate, the atrophy affecting not only the choroid but also the posterior layers of the retina. Destruction of the choriocapillaris probably always occurs at the site of the exudation. With destruction of this layer the posterior layers of the retina are deprived of adequate nourishment and therefore degenerate. Scar tissue is found not only in the choroid but often in the deep layers of the retina, frequently uniting these two membranes.

Symptoms. Pain is not prominent. Loss of vision occurs in portions of the fields of vision corresponding to the affected areas, with diminution of vision in contiguous parts from impairment of nutrition. Photopsia is manifested variously during the acute stage; micropsia is sometimes observed.

Treatment during the acute stage may accomplish much; nothing can be done after atrophy develops. Rest in bed; nourishing diet; protection of the eyes from light; abstinence from near work; mercury inunctions to the point of saturation and potassium iodide in increasing doses are the chief indications.

Fuchs gives anatomic descriptions of three recent cases of luetic choroiditis, two hereditary and one acquired; of an older case of hereditary luetic choroiditis, and of a case showing luetic changes of the choroidal vessels. Gummas occurred most frequently in the ciliary body; more rarely in the iris and have only once been described in the choroid. The ciliary body in the first case remained free from inflammation. This case showed that in hereditary luetic choroiditis infiltration commences in the choriocapillaris, where it reaches its greatest thickness and that the vessels are affected early. In the second case, one of severe irido-cyclitis with moderate choroiditis, the infiltration of the choriocapillaris was not greater than in the exterior strata of the choroid, and nowhere presented a specific character. In the third case, in consequence of the development of tough connective tissue. there was obliteration of the vessels. In the fourth case, of acquired lues, the iritis occurred with the exanthem and led, half a year after infection, to chorio-retinitis and, in spite of proper treatment, to blindness. The choroid was detached by coagulated fluid, and the iris revealed diffuse infiltration to the suprachoroid, but not the choriocapillaris; it thus differed from the usual choroiditis. Beside the diffuse infiltration, single foci of lymphocytes existed inwards to the layer of the larger blood vessels.

The fifth case was remarkable on account of the intense alteration of the choroidal vessels without inflammation, and without damage to the retinal vessels. The choroidal veins were normal, but there was hardly one perfectly normal artery. The changes were of three kinds: 1. Hyaline thickening of the walls, which was so homogeneous that the individual strata and the muscular fibres could not be distinguished. 2. Thickening of the intima by a new formation on the internal elastic layer, obstructing the lumen of some smaller arteries. The posterior ciliary arteries showed the same condition. 3. Conversion of the vascular wall into an almost structureless mass. This alteration was distinguished from a hyalin degeneration by the vascular wall not being thickened, but thinned. (Graefe's *Arch. f. Ophth.*, V. 97, p. 85.)

Clapp observed in a child, aged 5 months, congenital syphilitic choroiditis of the left eye. In both eyes, between iris and lens, there were about ten peculiar, fringe-like bodies completely encircling the pupil, being almost black, with rounded ends leaving a very small pupillary space, through which the outline of the nerve could be seen with difficulty. The borders seemed somewhat blurred. Clapp thought that a hypertrophy of the ciliary processes might have been caused by the toxins of the spirochete.

Gumma of the choroid. Uhthoff gave the clinical history of a woman, aged 59 years, with positive Wassermann reaction, who a year before admission was successfully treated for a bilateral specific ocular affection (O.D.=vitreous opacities; O.S.=iritis); she then returned with a violent iritis of the right eye. In spite of specific treatment a gumma developed at the lower temporal portion of the equator, extending to the limbus. It took the form of a yellowish-gray prominence and led, with severe pain, to complete blindness. Tension was normal. Enucleation had to be resorted to. The affection was very extensive, involving almost the entire temporal half and the lower portions of the eyeball. The gummatous mass protruded through a perforation at the equator to the exterior and interior of the globe, pushing the strata of the sclera forwards and backwards. The points in this case are that the gumma was preceded by an iritis and that it originated in the choroid and not in the ciliary body, its most frequent location. It was a late symptom of syphilis, other secondary symptoms being absent. In this respect the case was unique, since syphilomata of the choroid and the ciliary body most frequently occur in the first year after infection. The prognosis was unfavorable, corresponding to the general clinical experience that about 64 per cent. of the affected eyes become blind.

SYPHILITIC RETINITIS.

This subsection should be read as a part of pp. 11323 and 11394, Vol. XV of this *Encyclopedia*.

The condition known as diffuse syphilitic choroidoretinitis, the diffuse syphilitic choroiditis of Förster, is characterized by the presence of fine, dust-like opacities in the posterior part of the vitreous, blurring and redness of the optic papilla and by alterations in the macular region and in the vessels.

The diffuse syphilitic retinitis of Jacobson is a later secondary manifestation of syphilitic infection. This disease may result from hereditary syphilis. It may be unilateral but is usually bilateral. Other forms are: relapsing syphilitic central retinitis, syphilitic hemorrhagic retinitis, syphilitic arteritis of the retina and syphilitic perivasculitis of the retina.

The first of these is a rare disease characterized by relapses and by ophthalmoscopic signs limited to the retina.

Vision is often suddenly reduced but improves markedly during the intervals, although after repeated attacks it may be permanently diminished. The macula looks gray or grayish-yellow, and may show small, white points arranged in groups. Pigment spots appear after the disease has lasted for several years. Micropsia has been noticed in these cases, and sometimes the disease passes into diffuse syphilitic retinitis.

In a case reported by Fuchs the patient acquired lues at the age of 17; there were no manifestations of the disease until he was 36 years old, when he first noticed a disturbance of vision in the right eye which passed away after a few weeks. Subsequently the disturbance relapsed more and more frequently and finally became permanent. The subjective symptoms were a slight diminution of the central vision and the presence of a positive scotoma. With the ophthalmoscope faint clouding of the retina surrounding the fovea (which itself appeared as a small, red disk), could be seen. Occasionally minute yellowish or white spots would appear in that area. Later on the macular area showed fine pigment changes. Only once did it seem as if the refraction of the cloudy portion of the retina was weaker than the surrounding area by 1 to 2. Nine years after the first attack in the right eye similar symptoms appeared in the left. The case is one of the mildest recorded, and its characteristics are: the attacks increased in frequency; the positive scotoma, at first present only during attacks, becoming permanent later on; and the diminution of the central vision was never great.

The ophthalmoscopic changes were very slight. The ultimate cause lies apparently in an affection of the arteries supplying this region. The relapsing character of the affection can be explained most easily.

The case of central recurrent retinitis which Hirschberg had under observation for 27 years, showed frequent recurrences and responded well to anti-luetic treatment. A parafoveal focus remained after one attack, and a bluish infiltration subsequently appeared in this neighborhood, suggesting a partial blocking of the blood at the old focus. A scotoma with full central vision finally resulted.

Verhoeff reports the histologic findings in a case of syphilitic retino-choroiditis, which, on account of the location of the process, would have given the typical field defect of retino-choroiditis juxtapapillaris (Jensen) if the lesion had been less extensive.

Syphilitic hemorrhagic retinits, also a rare affection, is characterized by opacitis in the posterior part of the vitreous humor and by numerous hemorrhages. The arteries are small and the veins are enlarged and tortuous.

In *syphilitic arteritis of the retina* the arteries appear as gray or white bands and finally disappear through endarteritis obliterans. The veins are enlarged. The retinal symptoms are few. The visual changes are slight; vitreous opacities, hyperemia of the disk and blurring of the margins are not marked; night-blindness is absent.

Syphilitic perivasculitis of the retina has been described by Scheffels. The nerve head is hyperemic, the veins are enlarged and tortuous and surrounded by hemorrhages. The arteries may be normal and the retina transparent.

In Ischreyt's patient, a man of 29 years with lues, the arteritis and periarteritis led to obliteration of the vessels and formation of connective tissue in the vitreous in both eyes of the character of retinitis proliferans. An arc-like figure surrounded a small pigment on the nasal side and posterior synechiæ and pigment on the anterior capsule were also seen in this instance.

Exudative retinitis. In Crigler's patient, a girl 14 years of age with hereditary lues, the retina was elevated unevenly as far as the equator. At the anterior border of the elevation were small hemorrhages and one or two ampullated veins. In the lower temporal periphery there was an area of chorio-retinitis with small hemorrhages. The retinal vessels were distinct until they reached the periphery. A massive exudation occupied all except the lower nasal part, where the background presented a silver-white appearance, with cholesterin

crystal deposits in different parts of the retina. Localized adhesions occurred between the choroid and the retina. About these points of adhesion the choroid was degenerated, the chorio-capillaris being entirely destroyed.

Usually the retinal changes are more advanced than those of the choroid, but the reverse may be true. The outer layers of the retina are destroyed at many points, while the inner layers show masses of irregularly arranged pigment. Müller's fibres are thickened and the blood vessels show the typical vascular changes of syphilis.

Diagnosis is made by the ophthalmoscope; by the patient's history; by looking for and finding other syphilitic lesions; and by the luetin test and Wassermann serum reaction.

The *prognosis* depends largely upon the time of the beginning of treatment. Energetic anti-luetic treatment affords great improvement in the condition, but when the treatment is delayed there may be grave retinal and choroidal lesions with loss of vision.

Mercurial inunction is of the utmost importance and should be pushed to the limit of tolerance. In the later stages the use of iodide of potassium is advisable. The eyes should be protected from the light.

Retinitis proliferans is to be distinguished from other unusual types by the development of dense vascularized masses of connective tissue. These masses are whitish in color and take their origin from the retina, subsequently projecting into the vitreous, and in some cases extending toward the ora serrata. They may be very extensive and obscure the disk and adjoining fundus. As complications of this condition may be mentioned newly-formed blood vessels, hemorrhages, retinal detachment, and vitreous opacities. Syphilis is believed to be the underlying cause in most cases. See p. 11377, Vol. XV of this *Encyclopedia.*

SYPHILIS OF THE OPTIC NERVE.

Syphilis ranges third in the etiology of optic neuritis. Diagnosis is made if the onset is sudden; by the marked loss of vision and the recognition of the swelling in the nerve by the ophthalmoscope. If the papillitis is accompanied by perivasculitis, exudation and numerous hemorrhages, particularly if these changes tend to involve the retina, syphilis should be suspected.

There is swelling of the nerve head which projects beyond the retina. The retina adjacent to the nerve is thrown into folds. Examined microscopically there is edema, extravasations of blood, and varicosities of nerve fibres. In interstitial neuritis the process begins

in the sheaths, and septal edema, cellular infiltration and fibrinous exudation are followed by a new formation of connective tissue. Atrophy of the nerve fibres follows and leads to scotomata and sector-like defects in the field of vision.

All degrees of papillitis may result from syphilis. The optic nerve may be affected throughout its entire course, or any part of the nerve may be the site of the inflammation. When the ocular end of the nerve is affected, the papillitis resulting is usually moderate in degree. Syphilitic neuritis is rarely confined to the papilla but extends to the retina. The condition is accompanied by perivasculitis, exudation and hemorrhages, with perivascular infiltration of small, round cells. Inherited as well as acquired syphilis may produce optic neuritis.

The disease may be acute or chronic. It may come on suddenly and reach its greatest development in a few days or it may come gradually, attended by progressive loss of vision.

The prognosis must be guarded. If due to syphilis, the prognosis may be favorable, but no one can tell what the final outcome will be.

The usual antisyphilitic remedies should be used with the greatest vigor, beginning with mercurial inunctions, and accompanied by pilocarpin and the iodide of potash. Salvarsan is advised by some authors, while others avoid it in all nerve affections.

In a syphilitic suffering from a hyperplastic sphenoiditis and ethmoidal abscess, an intravenous injection of salvarsan was given, and two days later vision was very much reduced. Charles, in reporting this case, believes it is preferable to use mercury injections and inunctions rather than to give salvarsan where the optic nerve is already involved.

Stieren has seen optic neuritis improve rapidly under salvarsan, but with more secondary atrophy than when treated with mercury. He believes that salvarsan induces optic atrophy, and that the patients should be warned that their sight may be worse after the administration of salvarsan or neo-salvarsan. Argañaraz reports 28 cases in which grave lesions of the uveal tract and cranial sensory nerves followed the therapeutic use of arsenobenzol. He believes that optic neuritis occurring after the use of salvarsan, whether it be from syphilitic or arsenic poisoning, is aggravated by additional injections of salvarsan. In patients attacked with optic neuritis, therefore, the use of the drug is contraindicated, and since optic neuritis may occur without obtrusive symptoms, it should be looked for with the ophthalmoscope before salvarsan is given.

Ormond would not advise the use of salvarsan in the acute stages,

having had one or two cases in which a severe neuroretinitis resulted from its use. He thinks it advisable to use this very valuable remedy after the acute condition is over, and to be content with mercury during the inflammatory stage.

Spiller and de Schweinitz have observed three cases in which removal of a few cubic centimeters of cerebrospinal fluid has had a remarkable effect on the swelling of the optic nerves. In the first patient a decrease of one diopter was noticed after each lumbar puncture.

In Neumann's clinic in Berlin it has been shown that 81.9 per cent. of infants suffering from hereditary syphilis have optic neuritis. Mohr and Beck examined 128 children under one-and-a-half years, suffering from congenital syphilis. They found optic neuritis in 62 cases and consider it a valuable diagnostic sign of congenital syphilis. Two cases of optic neuritis following tumors of the hypophysis have been reported by Shukano. In both of these there was apparently syphilitic gummata in the region of the sella turcica.

McCaw presented a case of a young man 26 years of age, who suddenly noticed that he was unable to read. Accompanying the diminished vision there was diplopia and metamorphopsia. The disks were swollen I D., the vessels in the right eye were tortuous. Lower temporal vein showed alternate dilations and constrictions—an endovasculitis—and in the left eye there was an exudate just below the macula. The Wassermann reaction was positive. Diagnosis was a neuro-retinitis with central choroiditis in the left eye.

Wilder has reported two cases of optic neuritis caused by leptomeningitis. See, also, **Choked disk,** p. 2074, Vol. III of this *Encyclopedia.*

SYPHILITIC OPTIC ATROPHY.

In addition to the remarks on this subject elsewhere (see, e. g., p. 9059, Vol. XII of this *Encyclopedia*), attention is drawn to a case of bilateral optic atrophy in a seven-year-old boy reported by Weber. He was able only to count fingers in a good light. There was horizontal nystagmus. Both pupils were moderately dilated and neither of them responded to light or accommodation. Ophthalmoscopic examination showed nearly complete optic nerve atrophy in both eyes. X-ray examinations furnished no evidence of anything abnormal at the base of the skull. There was no obvious hydrocephalus or cranial deformity, nor were there signs of disease anywhere in the body. But his blood serum gave a positive Wassermann reaction, so did that of his mother and one of his sisters, while another sister had been treated for congenital syphilis.

Weber reported another case of bilateral optic nerve atrophy in a child of three-and-a-half years. Physically and mentally the child appeared fairly normal. There was a history of infantile convulsions up to the age of 14 months. The child's blood serum and that of the mother gave a positive Wassermann reaction. A younger brother of the father was said to have had a blind, prematurely-born child.

Among 19,893 patients Kirkpatrick observed 44 cases of optic atrophy, 7 of these being classed as primary, 37 as secondary; but of the latter only 3 followed acute neuritis. In the other 34, post-inflammatory changes were very slight. Of these 34, 32 occurred in males. None of them gave any history of previous severe illness. In 22 out of 26 cases there was a positive Wassermann reaction and one other patient stated that he had had syphilis.

Ischreyt's case relates to a man of 36 years in whom visual disturbances and frontal pain were accompanied by slight temporal contraction of the visual fields with bi-temporal irregular scotomas. A skiagraph showed enlargement of the sella turcica; the Wassermann reaction was positive. A diagnosis was made of lues at the base of the brain, affecting the lower aspect of the rear of the chiasm. The bi-temporal scotoma was permanent in spite of marked improvement of vision. Salvarsan failed to help, but persistent mercurial treatment gradually restored the vision.

A case of optic atrophy in a young man has been shown by Holloway. General physical examination was practically negative with the exception of a slightly positive Wassermann reaction. But the man's head was of a modified tower-skull type. Vision O. D.=fingers at 15 inches; O. S.=$6/15$. There was a divergent squint of the right eye measuring 10 degrees on the perimeter. X-ray plates showed an enlargement and displacement of the sella turcica, and the massive bony development of the face. Each disc showed a well-advanced atrophy.

Suker has exhibited two patients with tabetic optic atrophy, both of whom had been treated by ventricular injections of mercury. One man had received three injections, and his fields of vision had perceptibly increased. In this instance 60 cc. of ventricular fluid was withdrawn before the injection. He received $1/20$ to $1/50$ of a gr. of bichlorid of mercury and his mentality had a decided change for the better. This writer has also reported two other cases, one a man with senile dementia, and a girl 16 years of age. In both of these cases there was marked improvement following intraventricular injections.

Schoenberg reports the results of experimental work pursued with the intention of finding a more efficient method of reaching the optic

paths by curative agents, and suggests another way of treating optic nerve affections of syphilitic nature which do not respond to the classical antisyphilitic treatment. Dogs, rabbits and cats were used to determine to what extent the optic nerve would stain when the staining fluid was injected into the blood, the spinal canal, the subdural cranial cavity or the lateral ventricles. He found that the cranial intraventricular injections gave the best results. Medication introduced into the spinal canal becomes enclosed almost immediately, and does not reach the brain cortex and optic nerves. If it does the quantity is so small as to be valueless. The conclusion is that the cranial contents and optic nerves cannot be properly reached by any other route but that of the cranial subarachnoid space or the ventricles of the brain. For cranial subdural injection the skull was trephined about 1 cm. to the right of the median line over the parietal bone. For injection into the lateral ventricles the needle was introduced perpendicularly through the trephine opening into the ventricle.

Krauss and Brown have reported a case of unilateral optic atrophy due to syphilis in a 13-year-old girl. Vision in the affected eye, which was reduced to the faintest light perception in the beginning, improved to hand movements at a distance of six inches after three months of anti-luetic treatment. A man 34 years of age, whose vision was reduced to hand movements in one eye and faint light perception in the other, because of optic atrophy, in three months improved so that he could find his way about the hospital. The treatment consisted of potassium iodid, mercurial inunctions, and four injections of neosalvarsan. Espey states that his records teach the necessity for curing syphilis in the secondary stage at least, as the only means to ward off atrophy of the papilla from subsequent tabes.

THE OCULAR MUSCLES IN SYPHILIS.

Syphilis is by far the most frequent cause of paralysis of both the extraocular and intraocular muscles; including tabes, it is probably the etiological factor in at least 75 per cent. of all cases.

Symptoms.—Paralysis of the external muscles of the eye present certain characteristic symptoms which are present in varying degree in all cases; diplopia, vertigo, limited motion of the eyeball in the direction of action of the affected muscle, tilting of the head to correct the diplopia, false orientation.

The seat of the lesion producing ocular paralysis, may be cortical, nuclear, fasicular, basal or orbital. Lesions of the cortex never cause paralysis of individual muscles, with the exception of ptosis, conjugate paralysis, being the result of such lesions. Lesions on the floor

of the fourth ventricle produce paralysis of several muscles and generally it is bilateral. Fascicular lesions as a rule cause oculomotor paralysis of the same side, with paralysis of the extremities of the opposite side. Basilar lesions, as a rule, affect various nerves in succession, as those supplying the ocular muscles, the facial, the trigeminus, the optic nerve. In orbital lesions the muscles and the nerves are usually affected mechanically and are diagnosed by symptoms indicative of an affection within the orbit, such as pain produced by pressure on the eyeball, protrusion of the eyeball and monocular optic neuritis.

Paralysis of the intraocular muscles is frequently caused by syphilis. It is generally unilateral but may be bilateral.

The Argyll Robertson pupil, the condition in which the pupil fails to contract to light but does to convergence and accommodation, is quite frequent in tabes. It is usually bilateral but may be unilateral. With regard to the seat of the lesion, de Schweinitz says it has been placed by some authors in the fibres which pass through from the proximal end of the optic nerve to the oculomotor nuclei, and by others it is considered to be nuclear.

Ocular palsies are most frequent in later stages of syphilis, especially is this so of the intraocular muscles. The third nerve is the one most frequently involved. It may be partially or completely affected.

Palsy is indicated by complete ptosis of the upper eyelid and the patient is unable to move the eyeball except outward and downward, this movement being due to the intact sixth and fourth nerves. The pupil is dilated, and does not react to light or accommodation. Diplopia is present. (Stieren.) See, also, **Ophthalmoplegia**; **Tabes dorsalis**, and **Muscles, Ocular** in this *Encyclopedia.*

GUMMA OF THE OPTIC CHIASM.

In a case reported by Bonnefon and Opin there was, when first seen, paralysis of the oculomotor nerve and slight discoloration but no choking of the disks; only a mild papillitis. The patient was in a stupor when next seen and the pupils were dilated ad-maximum. At autopsy, behind the chiasm the gummatous mass was found to extend from the interpeduncular groove to the stem of the hypophysis on the left side, completely destroying the third nerve and the beginning of the optic tract; while on the right side the third nerve could still be recognized and the tract was normal. At the level of the chiasm the gumma had developed more to the right side, completely displacing the chiasm toward the left. There had been enormous periarteritis of the right carotid from which the lesion had spread toward the chiasm.

SALVARSAN (ARSPHENAMIN AND NEO-ARSPHENAMIN) IN THE TREATMENT OF SYPHILIS OF THE EYE.

Stephenson has held salvarsan to be a well-nigh specific remedy in primary and secondary syphilis; and to act speedily and satisfactorily in some diseases of the eye, particularly those of the uveal tract. It is best applied in a series of two to four injections into the veins, each of a maximal dose. But each dose should be followed by mercurial inunctions, and the whole treatment continued over six to twelve weeks.

The abortive action of salvarsan in the primary period gives it a very valuable field of usefulness. As already indicated, about 40 per cent. of cases of initial lesion, which can be distinguished by the demonstration of the spirocheta pallida, show a negative Wassermann for one or two weeks after the lesion's appearance. In these cases there is a reasonable prospect that syphilis may be aborted—a prospect that justifies a vigorous attempt with salvarsan. This of course makes the early diagnosis of the initial lesion a matter of great importance.

After this brief stage of promise has passed the prospect of cure rapidly changes. It becomes less promising from week to week, and after secondaries are well established it almost or quite vanishes. That sad conclusion has been forced upon us by the accumulated evidence of recurrences in cases treated in the secondary stage. It has gradually forced the salvarsan advocates from the use of a single massive dose to courses of many repeated doses in combination with the most vigorous mercurial treatment. There the method now rests (Pusey).

The results obtained with salvarsan in the treatment of a number of eye conditions at the Illinois Eye and Ear Infirmary have been reviewed by Orcutt. Of five cases of optic atrophy, three improved and two showed no change. Two cases of neuroretinitis were completely cured. Improvement occurred in two cases of interstitial keratitis. One case of paralysis of the third nerve was completely cured. Improvement was obtained in two cases of ophthalmia which would have been practically hopeless without salvarsan.

According to McDonagh, salvarsan does not act directly upon the spirochete, but by increasing the quantity of oxygen active in the serum of the patient. He points out that all trivalent metals introduced into the organism have this same oxydo-reducing power.

Koenig has reported three cases of parenchymatous keratitis cured with salvarsan, improvement being rapid in body as well as in the eye. One of the cases had stubbornly resisted all other forms of treatment.

Maucione describes in detail a number of clinical observations of

cases in which the various anti-syphilitic remedies were employed for ocular conditions. He arrives at the following conclusions: neo-salvarsan, with proper precautions may be employed in the treatment of all syphilitic manifestations in the eye and its appendages at any stage of the disease, without fearing accidents to the organism. Neo-salvarsan certainly manifests a greater, more rapid, and more constant therapeutic action than mercury or iodin in syphilitic disturbances of the eye. Mercury and iodin when combined with neo-salvarsan, are more stable and more intense in their action. In cases of increased ocular tension, secondary to affections of the uvea, the beneficial action of neo-salvarsan is definite and more rapid than that of mercury and iodin.

As to the possible ill effects of salvarsan, both on the optic nerve and the motor nerves of the eye, opinion is still divided. Trantas saw ophthalmophlegia develop eight weeks after the use of the drug. Among 370 cases treated with salvarsan, five ocular muscle palsies have been reported, while Stern found only three instances among 5,000 cases of syphilis.

On the other hand, Fleming, Igersheimer and others attribute the palsies and optic atrophies to syphilis and not to the drug. Goerlitz, Geronne and Gutman think that salvarsan changes the course of syphilis so that the late symptoms are likely to appear earlier. Fehr, from 2,700 cases of syphilis treated, concludes that the drug is not harmful; the relapses and paralyses have become less frequent since it has been used more freely and in larger doses; that it fails only in those cases in which other anti-syphilitic treatment fails; that it is more rapidly effective for conditions that yield to mercury and the iodides; and that more is to be expected from it as we learn to use it to better advantage.

The contraindications to its use, according to Lieuen, are disorders of the general circulation, long-standing tabes, chronic nephritis, diabetes and old age. To these Stuelph adds serious lung disease other than tuberculosis, visceral lues, gastric ulcer, alcoholism, degenerative changes of the nervous system, and febrile conditions. He also excludes it from the treatment of severe congenital lues in the newborn.

Treatment of ocular syphilis with galyl. According to the *Rév. Intern. de Méd. et Chir.*, Jan., 1917, galyl is a powerful anti-syphilitic remedy. In order to cure cutaneo-mucous affections the dose need not exceed 0.30 grammes. This dose may be repeated twice per week. In the vast majority of cases the injection of a dose of 0.30 gm. is well borne. In one case out of 116 it was followed by a violent reaction in

a tabetic subject. Injections of 0.20 and 0.15 grammes cause no appreciable reaction. They can be repeated several days in succession and thus are very effective. By injecting a feeble dose every day we gradually introduce into the syphilitic body a quantity of the remedy equally as large as if we made the doses weekly ones and large.

These daily injections of a small dose are particularly indicated in syphilitics who present a bad general condition and who should not be exposed to strong reactions.

The *mixed treatment with galyl and mercury* is very efficacious and well borne. Galyl has a happy influence on mercurial stomatitis. In cases of stomatitis it is best to substitute for a mercurial injection a weak one of galyl, which improves the affection of the mouth and permits of a quick return to the mercurial medication.

In the same dose galyl is much more effective than neo-salvarsan. It is even superior to salvarsan in anti-syphilitic power. It has, moreover, the advantage over this remedy of being much more easily handled. Galyl is therefore considerably better than the other products, according to the report above referred to.

Richard finds galyl not inferior in anti-syphilitic power to the arsenic derivatives now commonly employed, and safe if properly used. It can be given by intravenous injection in doses of 0.2 grammes and at intervals of four days, and can be given in conjunction with mercurials. It seems better tolerated than salvarsan. He has seen a serious local lesion from escape of the drug into the cellular tissue. The general reaction, when it occurs, comes on in five or six hours, and lasts two or three hours. There is slight rise of temperature, malaise, and vomiting. In 220 injections no renal disturbance was noted.

There has been recently marketed a practically colorless soluble, colloidal calomel to be used for purposes of inunction in the treatment of syphilis, which, according to the proprietors, is free from the handicaps of other mercurials and insures superior results without risk, exposure or inconvenience to the patient. The directions are to use 3 grams, or 45 grains, to the inunction in a rapidly penetrating base, specially prepared for this purpose. Of the 45 grains of calomel, 84 per cent., that is, 39 grains, is pure mercury.

It is said that far more mercury can readily be thrown into the system by this means than ever will be needed in any case, two or three inunctions (78 to 117 grains of pure mercury) can be completely absorbed daily; there is absolute control of dosage, as no mercury is lost by evaporation; no pain due to the treatment; no danger from accumulative effects; ease and convenience of application, only 3 to 5

minutes being required for rubbing; complete absorption of the ointment within 12 hours or less; no odor; and entire absence of tell-tale signs on bed and underwear, the pink inunctions being barely visible on the skin.—(J. A. McC.)

Syrgol. A brownish-black substance containing 20 per cent. silver in the form of a colloidal oxide; used in gonorrheal diseases, especially of the eyes and of the genitalia. It is one of the products of the wholesale chemical works of B. Siegfried, Zofingen, Switzerland.

C. A. Hegner (*Muench. med. Woch.,* August 8, 1911) found the instillation of 5 per cent. syrgol, two to six times daily, extremely efficacious in the treatment of gonorrheal affections of the conjunctiva, causing rapid diminution in the number of gonococci and abatement of the inflammatory symptoms.

Wolffberg, like Hegner, expresses a favorable opinion on the action of syrgol in ocular affections. He prefers syrgol to the proteids of silver used hitherto. In a solution of only 1 in 1000 syrgol exercises a definite influence on suppurating conjunctivitis, but it is well tolerated by the normal eye in a concentration of 25 in 100. For the treatment of ocular affections the author recommends the use of 1 to 3 p. c. aqueous solutions, e. g., 1 p. c. solution in dacryocysto-blennorrhea and chronic blepharo-conjunctivitis; 1 to 2 p. c. solution in simple acute follicular conjunctivitis; 2 p. c. solution in acute follicular conjunctivitis in which trachoma is suspected; 3 p. c. solution in blennorrhea of the newborn and of adults. In the 82 cases treated by Wolffberg, the patients were given syrgol solution for treatment at home. Irritation or complications were never met with. The effect was, without exception, manifest immediately after the first instillations. Even in 1 in 500 dilution the drug proved equal in value to zinc sulphate in simple conjunctivitis.

A. Dutoit (*Archiv f. Augenheilk.,* Nov., 1913; review in *Ophthalmoscope,* p. 315, May, 1914) reports on the *subconjunctival and intraocular* use of the drug. For injections the solution was always warmed. The injection of 1 c.cm. to 2 c.cm. under the conjunctiva causes but little pain. The same holds good for the intrabulbar injection after puncture of the anterior chamber. The injections were repeated every second day, if necessary. The irritation stage, which comes on twenty-four hours after, seemed to Dutoit remarkably less than after an injection of 2 per cent. saline solution.

The results are summarized as follows: Four cases of ulcus serpens, one complicated with dacryo-blennorrhea. These were treated with syrgol injections. One case received five, two cases four, and one case three subconjunctival injections. The ulcerative processes were healed

on the twenty-second to the thirty-second day of treatment. The examination of the material in two cases gave pneumococci and staphylococci, once pneumococci, once staphylococci. Perforation of the cornea did not occur in any of the cases. Three cases of traumatic perforation of the globe. Two cases received one intrabulbar syrgol injection, and the other case received two. These cases all ran normal courses, and were discharged on the twentieth, twenty-fifth, and twenty-eighth day respectively. Two cases of panophthalmitis. One received three intrabulbar injections, the other, two intrabulbar and three subconjunctival. Healing occurred in the first case after one month, and in the second after two months. A case of flap infection after cataract extraction. This needed three subconjunctival injections, and cleared up on the sixth day of treatment and the tenth after operation.

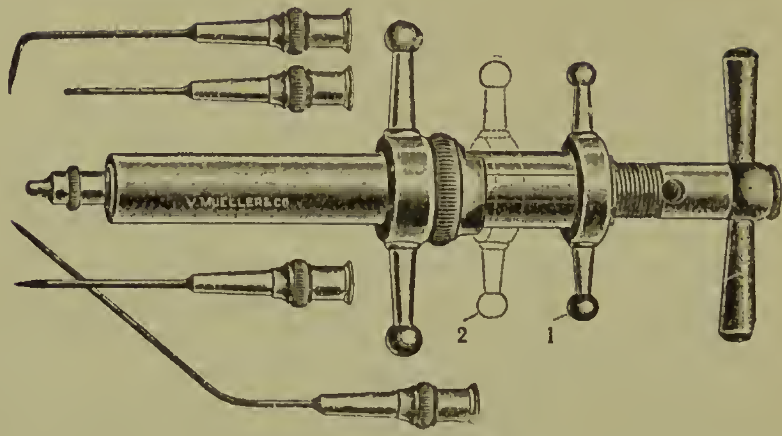
A. Siegrist (*Klin. Monatsbl. f. Augenheilk.*, 54, p. 288, 1916) says that since 1907 nitrate of silver has been supplanted at the clinic of Berne by collargol 3 per cent. and syrgol 5 per cent. in the *treatment* of *blennorrhea,* as their application does not, like the former, require eversion of the lids, and consists only in instillations. Fifty-three new-born children were treated with collargol, and forty-three with syrgol. The results, not only in ordinary but in cases of severe corneal complications in the new-born and adults, were equally good. Occasionally in the new-born child syrgol caused offensive diarrhea and disturbance in the general condition.

Syringe, Ophthalmic. These essential pieces of ophthalmic apparatus have been frequently described and pictured in this *Encyclopedia.* See, e. g., p. 419, Vol. I; pp. 6961, 6962 and 6964, Vol. IX; pp. 1668 and 1700, Vol. III. Of course the ordinary hypodermic (Pravaz) syringe is as much an ophthalmic as a general surgical armament. As regards the syringes shown under this present heading the legends sufficiently indicate their use. (See cuts on following page.)

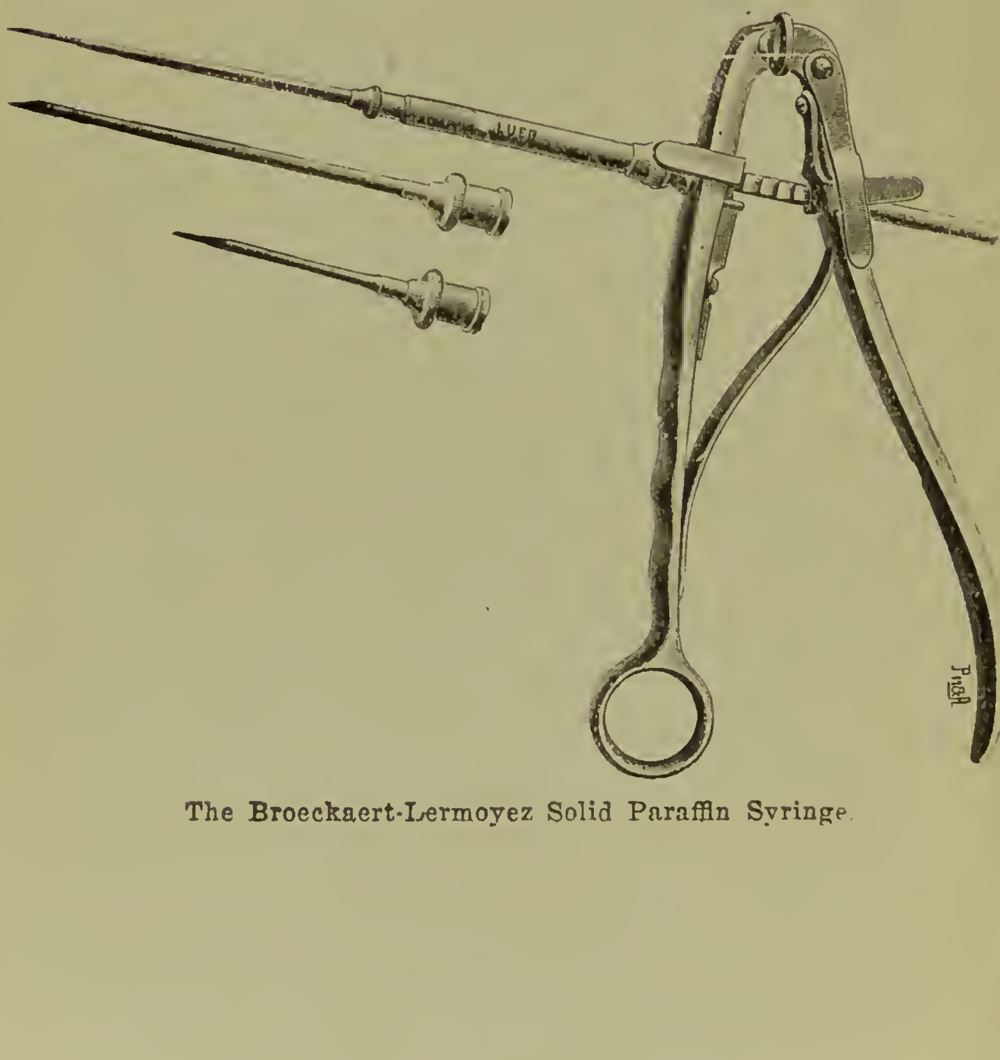
Syringe, Pravaz. A variety of hypodermic syringe having externally a nut working on a thread cut about the piston, so that the contained liquid may be extruded drop by drop.

Syringo-adenoma. This extremely rare dermal disease has been reported by Jarish as occurring in the eyelids. It develops as cysts lined by nucleated pavement epithelium from which spring cylindrical, duct-like cylinders of the thickness of a sweat gland duct. Several hypotheses have been advanced to account for this anomaly. According to Török it develops from the "rests" of sweat glands.

Syringomyelia. That abnormal condition in which there are cavities filled with liquid in the substance of the spinal cord. These cavities are surrounded by an abnormal tissue resembling that which is found

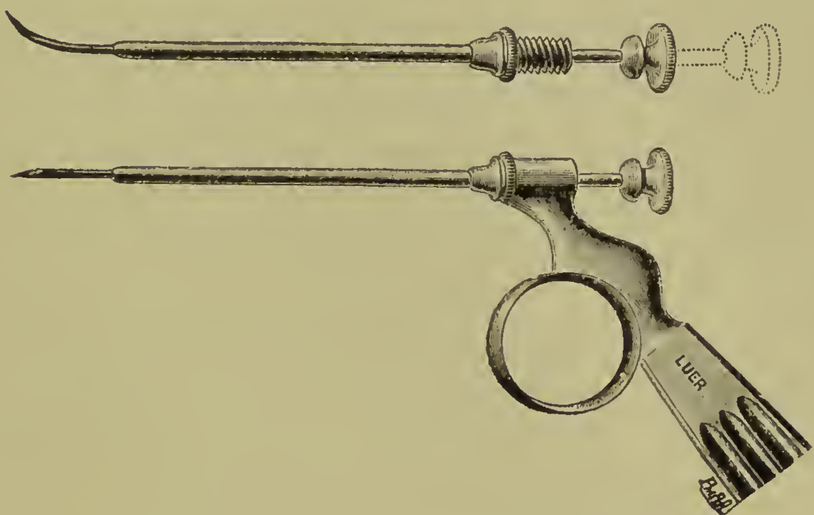


The Beck-Mueller Paraffin Syringe.

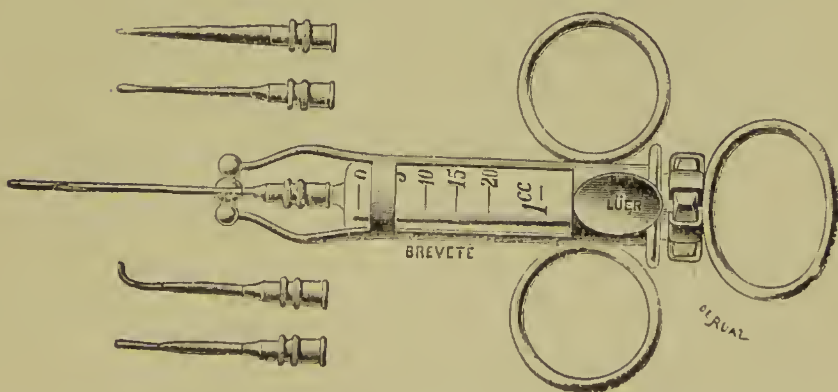


The Broeckaert-Lermoyez Solid Paraffin Syringe.

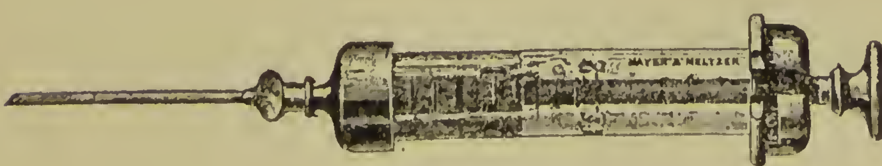
Dimmer's Anterior Chamber Syringe.



The Gault Solid Paraffin Syringe. (Luer.)



Luer's Glass Syringe. (Suarez de Mendoza Model.)



Schlosser's Syringe.

normally surrounding the central canal. The disease is due to hemorrhage and consequent softening and necrosis, and is believed to be dependent on some defect of development. It generally occurs in adults between the ages of twenty and thirty years, and is marked by muscular atrophy, loss of the sense of temperature and pressure, and by various vasomotor and trophic disturbances. The hydromyelia of children is a similar condition. Syringomyelia is sometimes associated with true leprosy. (*Dorland.*)

The ocular symptoms are described under this sub-head in **Neurology of the eye**, p. 8356, Vol. XI of this *Encyclopedia.*

Syrup of iodid of iron. This is a syrupy liquid—official in the U. S. P.—containing five per cent. by weight of ferrous iodide. It is a transparent, pale-green fluid with a sweet, strongly ferruginous taste and an acid reaction. In doses of from 20 minims to 2 drms. (1.30—8 c.c.) it is prescribed in anemia, especially in those cases attendant upon tuberculosis and the atonic diseases of children. It should be well diluted and taken through a glass tube to prevent discoloration of the teeth. It has long been a favorite remedy in phlyctenular disease.

Syrup, Simple. See **Sugar.**

Systematic examination of the ophthalmic patient. See **Examination of the eye.**

System, Bertillon. A system of identification based on various measurements of the body, color of the eyes, etc.

System, Cardinal points of an optical. See p. 1413, Vol. II of this *Encyclopedia.*

Systemic conditions in their relations to ocular symptoms. See **General diseases and ophthalmology,** p. 5350, Vol. VII, as well as under **Pupil** and **Neurology of the eye,** in this *Encyclopedia.*

Systole, Cardiac. See p. 5719, Vol. VIII of this *Encyclopedia.*

A single observation, that of B. Solger (*Cent. f. prakt. Augenheilk.,* p. 135, May, 1912) may be added. In the early morning when looking, with half closed lids (his back to the window), at a wall illuminated by the sun, he observed a round, well-defined spot appear periodically with the systole and disappear with the diastole. Solger believes it to have been a picture of his pupil. During the systole the iris receives more blood and grows more opaque; the central area, corresponding to the pupil, thereby appears lighter than its surroundings. During the diastole the difference between the peripheral and central areas becomes less and the light spot disappears.

Szokalski, Victor Felix. A famous Polish ophthalmologist. Born at Warsaw, Dec. 15, 1811, he studied at first in his native city. After a period of active service in the army, he resumed his studies at Giessen,

where he received his degree in 1832. For the next two years he studied ophthalmology at Heidelberg and Würzburg, and, under Sichel, in Paris. In Paris he received a second medical degree, presenting as dissertation "La Diplopie Unioculaire ou la Double Vision d'un Oeil." In 1844 he founded the Paris Society of German Physicians, and became its first president. In 1853 he returned to Warsaw, where he at once became chief surgeon to the Ophthalmic Institute, and in 1861 ordinary professor of ophthalmology and otology. He wrote a large number of articles, chiefly in Polish but also in German and French. The most important are *"Essai sur les Sensations des Couleurs dans l'Etat Physiologique et Pathologique de l'Oeil"* (Paris, 1840; 2d ed., 1841; Ger. trans., Giessen, 1842) and *"Fantazyjne Objawy Zmyslowe"* (Imagined Sensuous Appearances, Cracow, 1861, 2 vols.). He died Jan. 7, 1891.—(T. H. S.)

T

Tabacosis. Poisoning by tobacco, and chiefly by the inhalation of tobacco-dust.

Tabagisme. (F.) Chronic tobacco poisoning.

Tabari (full name, *Abul Hasan Ahmad b. Muh. at-Tabari*). This distinguished Arabian oculist (who flourished 970 A. D.) and body-physician of the Emir Rukn ad-Daula, composed an important work entitled *"The Therapeutic Book of the Eye,"* which, very unfortunately, has not come down to our day. He also wrote a comprehensive treatise on general medicine, which he called *"Hippocratic Treatments,"* in ten books. Of these, the fourth is devoted to the eye, and is still extant.

The contents of this fourth book, which, owing to the great industry—one might almost say genius—of Hirschberg, have recently been made known to the ophthalmologic world, are as follows, according to the chapters into which the book is divided: (1) Anatomy of the Eye. (2) Diseases of the Sclera. (3) Diseases of the Choroid. These are produced, for the most part, by the presence of excessive blood, and cause the hinder portions of the eyes to appear of too reddish a color. (4) Diseases of the Retina. These are four in number: (a) Jaundice with Tears. (b) Inward Sinking of the Drying of the Eyes with Pain, Due to Obstruction in the Retinal Veins, which nourish the Vitreous Humor. (c) Chemosis [panophthalmitis?] Whereby the Lid is Thrown Forward. (d) Migraine of the Eye. (5) Diseases of the Vitreous Humor. (a) Atrophy. (b) Hypertrophy. Inflammation of this humor does not occur, because it possesses neither arteries nor nerves. (6) Diseases of the Crystalline Humor. Secondary to other

diseases were: Backward-sinking, luxation, clouding. Primary was: Desiccation. In this last condition the crystalline became clouded, and so the light was clouded, as when a mirror becomes rusty and can no more reflect. [It should be remembered that, in all this, there was no thought of what is today called "cataract." In the time of Tabari, and indeed till the 18th century, it was believed that the crystalline body lay much farther backward of the pupil than is really the case, and that a cataract was caused by the falling (hence the name "cataract") of an errant humor into the considerable space believed to exist between the lens and the pupil. The lens was still supposed, as in antiquity, to constitute the essential organ of vision. Upon it fell the light, and, as was thought, in it, or on it, was formed the image which, by means of the foremost filaments of the retina (supposed to be most intimately connected with the lens-margin) were carried to the optic nerve, and, so, on to the brain.] (39) Cataract. Especially interesting are the definitions: "First definition: An effusion occurs between the crystal and the exit of the light in the uveal aperture [pupil]. Second definition: The thick morbid effusion settles between the arachnoid membrane and the uveal coat—according to others, in the plane of the pupil—and obstructs the vision at its point of exit.—Cataract arises either from without, through injury, between the arachnoid membrane and the uveal coat and cannot be operated on because of simultaneous obstruction of the optic nerve; or from within, in which case something runs down from the brain through the hollow nerves and fastens itself between the arachnoid membrane and the uvea, or else thick vapors from the stomach pass upward in two veins to the eye and, pressing in between the uvea and the arachnoid, thereupon become altered into a thickish humor." The operation for cataract, which, in those days, consisted, of course, in reclination, is described as follows: "In the backward corner of the eye, toward the end of the conjunctiva, an opening is made with the lancet. Then, with the needle, press softly in—that is the most effective and the safest way. Shove the instrument gently forward, and do not incline it into the depths of the eye, whereby you would only tear to pieces the arachnoid membrane and the cornea and destroy the sight. Gently push the instrument forward, and gaze upon it. If it stands in the same height as the pupil, thou wilt see at the same time both the cataract and the needle. Then press the cataract softly downward, until the pupil lies free. Then interrogate the patient, and, if he sees, draw the needle softly out. Should somewhat of the humors escape along with it, that does no harm, in case it is only a little; rather, it is a good sign." [They did not dream in those days that they had dislocated the lens! They merely supposed that they had pulled a tenacious

"errant humor" out of the space which they firmly believed to exist between the pupil and the lens. That a cataract was really the lens itself in a clouded condition, was discovered by Pierre Brisseau and Maitre-Jean in 1705.] In all, there are 54 chapters in this 4th (ophthalmologic) book of *"The Hippocratic Treatments."*

Tabari, though an excellent general clinician and a clear ophthalmographer, is said to have been surpassed by many as an ophthalmic surgeon.—(T. H. S.)

Tabasheer. TABASHIR. An amorphous, translucent, opaline variety of silica from the joints of the bamboo; it is used in the East as a medicine, and becomes transparent by absorption of water.

Tabellæ. See **Tablet triturates.**

Tabes dorsalis. LOCOMOTOR ATAXIA. POSTERIOR SCLEROSIS. Accounts of the eye findings in this disease occur under this sub-head in **Ophthalmoscopy, Medical,** p. 9042, Vol. XII, and under **Neurology of the eye,** p. 8357, Vol. XI of this *Encyclopedia.* See, also, **Tabes, Juvenile.** To this matter other observations are added here.

Locomotor ataxia is essentially a tertiary syphilitic degeneration of the posterior columns of the spinal cord and of the sensory nerve trunks, followed by atrophy of the same. It is marked by crises or paroxysms of acute pain, disturbances of sensation, incoördination, paroxysms of functional disturbances in various organs (such as in the larynx and stomach) and loss of reflexes. There are, also, trophic disturbances, especially of the joints and bones; incontinence or retention of urine, and loss of sexual power. The disease occurs after middle life and is most frequent in males. It runs a very chronic but progressive course, and although it may be temporarily arrested or its symptoms relieved, complete cures are rare. The *treatment of the eye symptoms* is that of the affection itself—*mostly symptomatic* and *antiluetic.*

Probably no other nervous disease has so many *characteristic eye-symptoms,* many of which are present long before the ataxic symptoms show themselves, and, indeed, the diagnosis is often made from the early ocular findings.

There is apt to be a contraction of the pupil, in some cases almost to a pin-point size (spinal miosis), although the pupil may react promptly to light and convergence. This condition is to be considered as either a paresis of the pupil-dilating fibres from disease in the front part of the aqueduct of Sylvius or as a paresis due to disease of the cilio-retinal centre in the lower part of the cervical cord. The pupils may be normal, or they may be accidentally dilated as a result of a general third-nerve paralysis. The Argyll Robertson pupil is found

most frequently in this disease. In this the irides do not react to light, or, if they do, it is but very sluggishly, but they react promptly in convergence. This symptom may be present when there is miosis, when the pupils are normal, or—as more generally occurs—when there is some inequality of the pupils (anisocoria). This is an early symptom of tabes, and it may make the diagnosis reasonably certain long before the development of any ataxic gait.

Piltz found that 43 per cent. of tabetics showed the synergic pupillary reaction, in which the pupil contracts synergically with the orbiculares. The orbicularis reflex is often more energetic than the convergence reflex. The convergence reflex is seldom absent. The psychic pupillary reflex of Piltz, in which the pupils react to the suggestion of light or darkness, has been observed.

Paresis of one or more of the ocular muscles with its accompanying diplopia occurs in 30 per cent. of the cases of tabes. These may be transient or permanent in nature. The sixth nerve seems to be the one most often attacked, but the third is not infrequently affected, together with its branch to the levator palpebræ, causing a true ptosis. Paralysis of accommodation occurs rarely in this disease, and is nearly always a late symptom.

There is often a narrowing of the palpebral fissure and a slight drooping of the upper lids, but, as the patient can by his will-power open them normally, it is not to be considered as a true ptosis. On closing one or both eyes there is often a marked twitching of one or both orbiculares. This symptom is not of much importance, as it is not infrequently present in persons who are perfectly well.

Epiphora is a symptom mentioned by some authorities, and is due probably both to a relaxation of the lower lid and to hypersecretion of the lachrymal gland. Berger claims to have frequently found a reduction of intra-ocular tension, but this contention is not borne out by other observers.

Some authorities mention nystagmus as a symptom of tabes, but probably Swanzy's term, ocular ataxia, is better. This consists in a nystagmus developing when the patient attempts to fix an object with his eyes, but which ceases the moment the eyes are at rest. Dissociated ataxic movements may be present (Uhthoff).

A symptom which occurs in at least 30 per cent. of cases is optic-nerve atrophy. It is an early rather than a late symptom, and cases are on record where it has preceded the ataxic gait twenty years. The atrophy is nearly always bilateral, although generally more advanced in one eye than in the other. As the atrophy advances there is a concentric contraction of the visual field, especially so to the outer side.

Central vision may remain good for a long time. Sometimes the field shows only a sector-like defect. As a result of the atrophy, color-blindness is not infrequent, the recognition of green being lost generally before that of red. The inequality of the pupils is probably explained by the atrophy of one optic nerve being much more advanced than that of its fellow.

Severe attacks of orbital and periorbital pain may precede optic atrophy. They usually occur early in the course of the disease. According to Gowers, when optic-nerve atrophy commences in the first stage of tabes, the progressive tendency of the atrophy is often great, while that of spinal lesion is slight. When amaurosis is an early sign, the disease is, as a rule, of long duration.—(J. M. B.)

Ocular signs and symptoms of tabes. A writer in *Le Monde Médical,* April, 1916, notes that in most cases of locomotor ataxia we are in the presence of an unsuspected attack of syphilis so that the patient has not undergone any systematic specific treatment. It is rare that the patient admits a primary lesion or secondary manifestations, or that a history thereof is to be found in his personal antecedents. It is mostly in cases of undiagnosed syphilis that tabes supervenes.

The *ocular manifestations of tabes* can be classified in three groups: (1) Pupillary disturbances; (2) Lesions of the disc; (3) Lesions of the ocular muscles.

Pupillary disturbances. The pupil, as we know, is subject to alternate movements of contraction and dilatation, varying according to the intensity of the light rays, the admission of which to the retina it is its function to regulate. This pupillary light reflex has its starting point in the retina, following the optic tracts to the spot where the ganglions of the base are joined up with the moto-centres. The propagation by propinquity of the sensation stimulates the origins of the motor fibres which transmit a centrifugal stimulus to the ganglia and ciliary nerves.

Lesions of the optic nerve modify the pupillary reflex. In presence of optic atrophy (neuritis) the centripetal path is more or less interrupted and according to the stage of the lesion the direct luminous reflex is modified or abolished.

In a subject suffering from unilateral optic atrophy if both eyes are closed and then only the damaged eye exposed to the light, its pupil does not contract. On repeating this manœuvre with the healthy eye both pupils react to the same extent. This is the so-called consensual reflex, the stimulation being transmitted by the healthy eye to the motor fibres of both eyes. This distinction between the direct luminous reflex and the consensual reflex is of the greatest importance. The

amaurotic eye contracts when the healthy eye receives a luminous impression. This phenomenon enables us to differentiate organic and hysterical visual defects and simulated amaurosis.

The loss of the consensual luminous reflex does not necessarily accompany lesions of the fundus of the eye in tabes, it may be normal on both sides even when the Argyll Robertson sign is positive. This raises the question as to the seat of the lesion which, in tabes or general paralysis, hinders contraction of the pupils. This problem is still under investigation. All we know is that the obstacle does not affect the centripetal path. However this may be the diminution or loss of the luminous light reflex exists apart from any change in the optic nerve in tabes and general paralysis.

The light reflex is more or less profoundly modified in the subjects of locomotor ataxia. Under normal conditions the pupil contracts rapidly and to its maximum extent. In tabes this contraction is slow and incomplete, indeed in some cases it does not take place at all. To make sure of the test the patient should be placed for some time in the dark-room in order to obviate unconscious accommodation and to secure a pupil dilated to its maximum. During the test the subject should be directed to look far off in order to avoid any attempt at convergence and accommodation. In short, Argyll Robertson's sign consists in the loss of the direct light and consensual reflex with retention of the accommodation reflex.

If a patient exhibiting the Argyll Robertson sign be instructed to look at and fix objects at a distance and then near objects it will be seen that accommodation persists for distance.

This sign is present very early and it is met with in general paralysis and certain cases of cerebral syphilis.

Inequality of the pupils is another sign frequently met with but it is not peculiar to tabes since it is seen in toxic amblyopia. The pupil may also display sundry changes in shape but there is nothing peculiar in this unless associated with the Argyll Robertson sign.

Dupuy Dutemps has called attention to atrophy of the iris, which loses its lustre and becomes dull.

Lesions of the papilla. Atrophy of the disc is common in the subjects of tabes and gives rise to grave disturbances of vision. It occurs in a rather special form so that it is easy enough to distinguish from atrophy due to other causes. Tabetic optic atrophy supervenes very insidiously and is not ushered in by any inflammatory phenomena. Seen by the aid of the ophthalmoscope the disc is white, with well defined margins, and the vessels are of normal calibre. This is not the case in atrophy consequent upon neuritis.

Atrophy is the ultimate terminal phase. Prior thereto the patient has visual disturbances that attract attention. There is narrowing of the field of vision and dyschromatopsia, he is unable to distinguish colors which he names wrongly, especially the green. Along with the shrinkage of the field of vision are areas of the retina where perception of colors is wholly abolished while in others it is approximately intact.

Lastly mention must be made of central scotoma, due to damage of the nerve bundle of the macula causing loss of central vision. This scotoma is rare in tabetics while it is common in alcoholic and tobacco amblyopia. In the latter case it is double, whereas in tabetics it is unilateral. The central scotoma of tabetics is accompanied by other lesions of the eye and narrowing of the field of vision.

The optic atrophy appears to be due to a perineuritic lesion.

Ocular motor disturbances. These disturbances may be summed up in paralysis of the 3rd, 4th and 5th pair of cranial nerves but especially the third pair. Paralysis of the internal rectus is the one most frequently met with.

These paralyses of the eye come on early and are then slight, or they are late and grave. The slight forms of paralysis belong to the pre-ataxic period of tabes, they are ephemeral, mobile and ill-marked but readily relapse. Paralyses supervening at the stage of confirmed tabes are graver, more extensive and are permanent.

The only treatment for all these symptoms is antisyphilitic. As a rule the treatment has no effect on the pupillary troubles which do not retrogress. Treatment by mercury or 606 has no other object than to prevent the further development of the specific meningeal lesions.

Paralyses or pareses in the pre-ataxic period on the other hand are amenable to treatment.

The atrophy of the disc sooner or later culminates in total permanent blindness, nevertheless treatment may delay its progress. In this connection it is well to point out that de Wecker has called attention to the fact that in these cases mercurial treatment may give the optic atrophy a jog. We must therefore give the matter of dose close attention and watch the state of the disc.

We may also have recourse to subcutaneous injections of strychnine, a milligramme daily. This drug certainly seems to have some effect in delaying the onward course of the disease.

Tabetic ocular crises. Ocular crises were first described, as W. G. Spiller (*Jour. Amer. Med. Assn.*, Mar. 18, 1916) reminds us, by P. K. Pel (1898), but have not been generally recognized, and only a few cases are recorded. Oppenheim, even in the sixth edition of his text-book, states that ocular crises with attacks of severe pain in the

eyes, secretion of tears, spasm of the orbicular muscles, and hyperesthesia of the eyes and parts about the eyes, are not to be accepted as tabetic until further experience has been obtained. It is desirable, therefore, that cases of this character should be made known. Oppenheim has observed hyperesthesia of the retina in tabes which interfered greatly with a testing of the light reflex, as the eyes filled with tears on every attempt to take the light reflex.

Pel's case was one of tabes with paroxysms affecting both eyes, of ocular phenomena consisting of irritation of sensory, secretory, motor and vasomotor nerves. The mental condition of his patient during the attacks was altered. The man was restless and irritable. The ocular attacks occurred with sudden severe burning and stabbing pain in both eyes, interrupted by short intermissions. Pronounced secretion of tears with photophobia soon followed the pain, and it was difficult for the man to see because of spasm of each orbicularis palpebrarum muscle. The attacks varied in their duration. Sight was not affected in the intervals. In one attack the conjunctiva of each eye was red and swollen, and the eyes and area about the eyes were hyperesthetic, so that examination of the eyes was impossible, and the man felt exhausted after the attack. The appearance of the eyes during an attack was like the condition produced by rubbing them in the presence of a foreign body beneath the lids. There is no mention of visual phenomena, and the optic nerves were normal. The condition was one of irritation of the trigeminal nerves, and the ocular pain was regarded as ciliary neuralgia. There was persisting paresthesia in the distribution of the trigeminal nerves.

Pel stated that until the time of his report no case of crises of one of the upper cranial nerves had been observed, as crises had been seen only in organs rich in vagus and sympathetic fibers. As the trigeminal nerve contains secretory, sensory, motor and vasomotor fibers, crises of this nerve might be expected, and this nerve is often affected in tabes.

Pel refers to reported cases of tabes with irritation of secretory fibers of the trigeminal nerves, as secretion of tears (crises lacrymales, dacryorrhée ataxique), violent sneezing (crises nasales) with paresthesia of the nose, and finally increased secretion of saliva (Patrolacci, Féré, Koenig, Klippel). Klippel observed disturbance of taste in tabes. Pel speaks of ophthalmia neuroparalytica and tabetic ulcer of the mouth, trophic disturbances of the trigeminus, occurring rarely in tabes.

Pel's case differed from the examples he quotes in that it presented a combination of symptoms with pain predominating and occurring

in sudden attacks, and therefore like tabetic crises. The hyperesthesia of the eyes and parts about the eyes during and following the attacks was important, and the spasm of the lids was regarded merely as a reflex act.

The case of ocular crises in tabes reported by Haskovec was not exactly like Pel's case. A man, aged 37, had frequent attacks of pain, secretion of tears, and left exophthalmos. The left exophthalmos after an attack of pain became so great that the eyeball almost came out of the orbit. The secretion of tears was intense. The description makes the location of the pain uncertain, but it appears to have been in the eyes. No visual phenomena are mentioned.

Knauer's patient, a woman with tabes, frequently had pain in the forehead with tenderness to pressure over the upper division of both trigeminal nerves during the pain. She had also pain in the right eye and adjoining region, with swelling and redness of the conjunctiva, free secretion of tears, photophobia, and contraction of the pupils. Only the right eye was affected in the first attack, but in later attacks the left eye became affected, as shown by redness and swelling, hyperesthesia, photophobia, sensation of a foreign body in the eye, and lachrymation. The most striking peculiarity of this case was that in one attack the right eye was affected and in another attack the left eye. Taste and smell were lost during the attack when there was hyperesthesia of the mucous membranes of the nose and throat; there was disturbance, therefore, in nerve supplies other than that of the trigeminus, but here there was loss of function, and not increase of function in another nerve territory. Knauer explains the loss in his case as a result of hyperesthesia of the mucous membranes.

Visual fields in tabes. The atrophy of tabes is generally thought of in connection with the optic nerve and disk. But its liability to involve the tracts should also be borne in mind. Fuchs (*Oph. Year-Book*, p. 293, 1912, and p. 257, 1913) points out that the central scotomas of which he has seen thirty cases are generally bilateral; and he regards them as essentially part of the general process. Such a tendency to bilateral involvement must of necessity mask lesions of the tracts behind the chiasm.

The *visual fields of 130 cases of tabetic atrophy of the optic nerve* have been pictured by K. Langenbeck (*Klin. Monatsbl. f. Augenheilk.*, August, 1912). The defects of the visual field for white generally commence at the periphery, rarely at the center: in 81 eyes of the present statistics from all sides, in 37 from the nasal, in 33 from the temporal side, in 25 from above, in 7 from below, in 18 from the center. A definite rule could not be established. In many cases, however, the

defect in both eyes showed a certain symmetry, e. g., from the temporal or nasal side, left or right.

In conclusion the writer believes that a specific form of visual field, absolutely typical for tabes, does not exist. Peripheral defect, contraction for colors and early loss of the sensation of red and green in the whole visual field are most frequent; a partial defect, with well-preserved function of the remaining visual field, is less frequent. The rather rare cases of central defect require repeated examinations with regard to retrobulbar complications. Hemianopic visual fields do not occur in uncomplicated tabetic atrophy of the optic nerve.

The occurrence of a sharply defined binasal defect of the visual fields in a case of tabes dorsalis is recorded by Price and Heed. The patient was a man of 48 years. His right vision was 6/30, and the left 6/21. The disks were pale, but the fundi were otherwise normal. There was a general contraction of the visual fields averaging 10 degrees.

Wechsler (*New York State Jour. Med.,* August, 1918) points out that it is generally accepted that *the optic atrophy in tabes* is primary and purely degenerative.

However, in 1902, Kéraval and Raviart claimed that optic atrophy in tabes and general paresis was not a simple, primarily degenerative process, while Marie and Léri, 1904, sought to bring this conception a step farther. The work of both fell on unreceptive soil. Stargardt, in 1913, exhaustively studied the subject and not only confirmed the work of Marie and Léri but altogether denied the existence of purely degenerative processes in tabes and paresis.

In view of recent investigations it is evident that the pathology of optic changes in tabes and paresis does not present the finality which, for instance, Uhtoff and Wilbrand and Saenger give to it. The questions are:

1. Are the pathologic changes in tabes and paresis giving rise to ocular manifestations fundamentally different from those occurring in interstitial-meningo-vascular syphilis?

2. Are the lymphocytosis, plasmocytosis and other inflammatory changes absent in tabetic and paretic eye palsies and optic atrophy and present only in so-called cerebrospinal syphilis?

3. Is the process on the one hand primarily degenerative and on the other consequent upon inflammation?

To all these questions the answer must be, No. There is an etiologic identity and pathologic similarity in all syphilitic processes, be they paretic, tabetic or so-called cerebrospinal syphilitic, evidently shown by the pathology.

In the opinion of Wechsler, syphilis is a continuous disease, and while for convenience of classification one may speak of a primary, secondary, tertiary, or even quarternary, or the old meta- and para-syphilitic stages, from the standpoint of pathology there is no fundamental difference between any one of those stages. The difference, if any, lies in the reaction of the structures of the body at various periods after infection, or in the varied action of the spirochete after numerous vicissitudes in the body. It may safely be argued that the underlying pathologic process of any syphilitic lesion, whatever its chronologic manifestation, is essentially of one character, differing only in degree at various times and under various conditions, and depending upon the structures involved. Thus, while in so-called cerebro-spinal syphilis the vascular, inflammatory, exudative process overbalances the degenerative changes, in tabes and paresis the latter is more marked and often completely overshadows the former.

From the study of the more recent investigations of the pathology of neurosyphilis, particularly with reference to optic changes, the writer concludes that there is no fundamental difference between tabetic neurosyphilis and so-called cerebrospinal or, better, diffuse neurosyphilis. It seems evident that an inflammatory process is behind every form of syphilitic involvement and that the spirochete is at the bottom of the reaction. Obviously, the inflammatory reaction is in direct proportion to the kind of tissue involved. There is every reason why the meninges should respond more violently than the parenchyma of the brain. The reaction, too, of vascular, interstitial structures will be of a different nature than that of parenchymatous tissue. But lymph and plasma cell infiltration and mast cells are the fundamental characteristics of syphilis. This picture occurs in tabes paresis and optic atrophy, just as it does in interstitial neurosyphilis or, say, aortitis. There is, therefore, no valid reason for calling a protean clinical picture cerebrospinal syphilis. In the first place, tabes and paresis are anatomically just as cerebral and spinal, and secondly, the pathology is based in all cases on a similar reaction to the same agent. Wechsler has, therefore, without being too consistent, used the term interstitial, or diffuse neurosyphilis, instead of cerebrospinal lues.

The same argument, it seems, holds true when we come to the pathology of special structures, such as the optic nerve. Evidently very careful examination has revealed inflammatory reactions, even in very old cases of optic atrophy. It would seem advisable therefore to drop the term primary optic atrophy or, rather, employ it in the sense that the atrophy takes place pari passu with the inflammatory, exu-

dative process. It is equally descending with an inflammatory neuritis, though the vascular changes are not nearly so violent. The deductions to be drawn are quite obvious. Without attempting to deal with the subject of therapy it may be well to point out that if the inflammatory character of optic atrophy will come to be recognized, we may be able to attempt rational and possibly hopeful treatment in cases which have hitherto been the despair of therapeutics.

A. J. Gibson (*Ophthalmoscope*, p. 707, Dec., 1914) reports a case of *dystrophy of both corneæ* in tabes. The patient, a man of about 60 years, apparently strong and healthy, complained of failing sight. R. and L. V.=6/18. T.n. Miosis. Argyll Robertson pupils. With ordinary oblique illumination, there seemed nothing amiss in the corneæ, but after dilatation and using the loupe, Gibson discovered a large number of greyish, ill-defined, and discrete dots in the posterior layers, giving a mottled appearance to the corneæ.

There were no inflammatory symptoms. The discs were distinctly pale. A colleague who examined the patient was unable to detect further signs of tabes. Two months later, vision had sunk to 6/60 with atrophic discs. The corneal appearance was unchanged.

The diagnosis of tabes dorsalis. Gordon Holmes (*Brit. Med. Jour.*, March 14th, 1914; abs. *Ophthalmoscope*, p. 336, 1915) believes one should early investigate *analgesia*. The first loss of sensibility to pin-prick is usually found on the lower limbs, and at first but partial. Patients, even in the so-called "preataxic stage," not uncommonly experience no discomfort from a pin-prick on any part of the lower limbs. Before this stage is reached, certain anomalies of sensation to pain are often present, as follows: (1) delay in the perception of pain; (2) abnormal sensations following the prick, as "burning," or "tingling," and (3) persistence of the pain, so that a patient may even try to "rub the feeling away." A common manifestation is an analgesic or hypalgesic zone around the thorax, the upper margin of which usually lies at the level of the second rib in front. In about 70 per cent. of the cases Holmes has found some loss of sensibility to pin-prick on an irregular and indefinite area in the centre of the face, especially on the nose and the neighboring portion of the cheeks. The sign is a valuable one, as it may occur very early in the disease. The diminution, loss, or alteration of sensibility to pin-prick is frequently present when the knee-jerks and the pupillary reactions are normal, and before ataxia or other prominent symtoms have developed. It is consequently, as the author says, the most important phenomenon in the diagnosis of the disease. Deep analgesia, not limited to the somatic structures, is characteristic of tabes dorsalis.

Disturbances of tactile sensibility form an integral part of tabes, but they are not so significant as analgesia. The sense of position should always be investigated in cases of suspected tabes dorsalis. Romberg's sign is a rough method of estimating its affection in the lower limbs and at the hips.

Holmes, speaking of the reflexes in tabes, does not attach the diagnostic importance to the disappearance of the deep reflexes that he does to some other symptoms. Moreover, the deep reflexes can be elicited in a considerable proportion of early cases, and, for that matter, in certain cases they are actually exaggerated, owing perhaps to the coincidence of syphilitic spinal lesions or a meningitis.

The Argyll Robertson sign is extremely common and very characteristic of tabes dorsalis, but it is often absent in relatively advanced cases, and the disturbance of the light reaction is occasionally not typical. Loss of the consensual reflex seems to be often the first sign of any anomaly in the reaction of the pupils. The latter, although they may retain their contraction with convergence, may react more slowly or less completely than normal—a kind of modified Argyll Robertson sign. In tabes the pupils are often small, but not always so, and they are frequently unequal in size and irregular in outline, although this is usually regarded as more significant of general paralysis. It should be borne in mind that the Argyll Robertson pupil may be met with not only in tabes dorsalis and general paralysis, but also in cerebro-spinal syphilis and (more rarely) in syphilis of the neighborhood of the upper end of the mid-brain. Slight ptosis is common in tabes dorsalis. Inasmuch as isolated ocular palsies present no special feature suggestive of tabes, their recognition may cause considerable difficulty. Tabes should always be suspected when a patient complains of a slowly progressive blindness, if the loss of sight is not due to a central scotoma, and, finally, if ophthalmoscopic examination reveals the appearances of a primary optic atrophy.

It is now generally admitted that tabes dorsalis is a post-syphilitic disease, although a positive Wassermann can be obtained from the blood serum in from only 60 per cent. to 75 per cent. of the cases. But when the cerebro-spinal fluid is tested quantitatively to the Wassermann reaction, a positive reaction is obtained almost constantly, as first shown by Hauptmann. Lymphocytosis of the cerebro-spinal fluid, together with increase of the globulin content, occurs in tabes, general paralysis, and in some cases of cerebro-spinal syphilis.

The writer sums up as follows: "We may therefore conclude that the characteristic subjective and objectively demonstrable disturbances of sensation are usually the earliest, the most important

and the most unequivocal clinical signs of tabes dorsalis; that they are frequently associated with loss of certain of the deep reflexes, especially of the ankle-jerks and knee-jerks, and with pupillary, ocular and other less frequent symptoms and physical signs; and that modern serological, cytological and chemical methods can supplement and confirm the clinical diagnosis based on these clinical signs, and make the positive or negative diagnosis of tabes dorsalis as certain as anything can be certain in clinical medicine.''

Treatment of tabes and of its ocular symptoms.

As before stated this is in practice, the treatment of the underlying disease. The conduct of ocular tabes is generally undertaken by the ophthalmologist in conjunction with the neurologist. However, a few observations on the subject here will not be out of place.

R. H. Hayes in his work (*Intensive treatment of syphilis and locomotor ataxia by Aachen methods;* Baillicre, Tyndall and Cox, London, 1914) holds that in spite of new methods and drugs mercury still holds the chief place in the management of this disease and it is, therefore, important that the inunction methods peculiar to Aix should be carefully explained by someone who has made a study of them on the spot. These methods undoubtedly have proved successful after the failure of treatment of the ordinary type. Some of the successful cases recorded by Hayes in late neurological lesions are striking and quite as good as anything that has been obtained by the use of *salvarsan* in similar affections. The writer admits the usefulness of salvarsan especially in early cases, but like all modern syphilologists insists on the need of thorough mercurial treatment in addition.

Carl Behr (*Klin. Monatsbl. f. Augenheilk.*, Vol. 56, Jan., 1916), believes certain cases of *tabetic optic atrophy* are hopeful if the diagnosis be made very early. A diminution in dark adaptation can be detected as one of the very earliest signs of tabes, and long before either the fields or the optic disc show any pathologic variation; likewise this sign is the first symptom of tabetic optic atrophy. He arrives at the following conclusions: In all tabetic nerve lesions, the earlier they are detected the better the results from treatment. Vigorous antiluetic remedies are indicated except in the following classes, in which they are absolutely contraindicated: (1) those with markedly diminished central visual acuity, early loss of color differentiation with normal or nearly normal boundaries for white; (2) marked concentric shrinking of the field, the white and color fields practically of the same area, with normal or nearly normal vision; (3) normal or nearly normal vision, photopsia and well-pronounced

atrophy. The writer claims to have found benefit from lumbar punctures, removing ten cubic centimeters of fluid once or twice a week during the course of antiluetic treatment; this result he believes due to the increased activity of metabolic processes in the central nervous system and a more rapid delivery to the affected parts of the curative agent.

Tabes fruste. (F.) Incomplete form of tabes dorsalis.

Tabes, Juvenile. Although the familial affection known as *Friedreich's disease* (see p. 622, Vol. I of this *Encyclopedia*) is sometimes spoken of as *juvenile tabes,* yet the pathologic entity to be treated here is in fact practically the same as the progressive, spinal posterior sclerosis of adult life.

One of the earliest papers on this subject is that of Stephenson (*Oph. Year-Book,* p. 54, 1908 and p. 73, 1909), who reports 5 cases, applying on account of impaired vision. They ranged in age from 10 to 14 years, except one, a woman, aged 24, whose sight had been failing for about one year. The condition is to be differentiated from hereditary optic atrophy beginning at puberty, by the appearance of papillitis and central scotoma in the latter. Stephenson thinks that a large proportion of children, where the sole obvious findings include amblyopia and optic atrophy, are instances of juvenile tabes; and the association in a syphilitic child of bilateral simple optic atrophy, with loss of knee jerks, would point to such a provisional diagnosis. Another suggestive combination is paralysis of an ocular muscle, with loss of the deep reflexes, in a syphilitic subject.

Jones lays special stress upon optic atrophy, Argyll Robertson pupil, anisocoria, and oculor-motor paralysis, in the recognition of juvenile tabes.

J. T. Duncan (*Canadian Practitioner,* October, 1909) speaks of *ocular conditions in juvenile tabes* and furnishes an account of a patient who, at thirteen years of age, complained of attacks of vomiting without gastric pains; these were followed one month later by severe pains in the head. Later, these were so intense as to cause her to throw herself about and scream, sometimes losing consciousness but again screaming as soon as she regained her senses. She frequently vomited during the paroxysms. She was later placed in a hospital but became gradually worse; her vision was not recorded but her mother thought it was normal. The diagnosis at this time was one of cerebral tumor, but permission to operate was refused. She was removed from the hospital "quite blind," and unable to walk. Pain and vomiting continued for a month later, when they suddenly ceased. She regained strength and in two years could walk,

after which she was sent to a blind asylum. No history of lues could be determined, although the mother had had two miscarriages, and the father died of supposed cancer, with severe pains in the head as the chief symptom.

Regarding the ocular manifestations, the lids opened and closed normally and there was no history of diplopia. There was a paresis of the right superior rectus, the extrinsic muscles being otherwise normal. The pupils were large and unequal, the left the larger, the pupillary edges being regular. The right pupil reacted but slightly to light and the left was fixed, yet both reacted in convergence. On examining the fundi gray atrophy was noted, but the vessels were normal. There was no anesthesia or loss of motor power, and the right knee-jerk was more pronounced than the left. Co-ordination of the legs and arms was perfect.

Duncan cites statistics of juvenile tabes from Cantonnet's article, showing that specific disease is as important an etiologic factor as in the adult form of the disease. Of the 88 cases which Cantonnet has collected from the literature, optic atrophy was found to be common; ataxia comparatively rare. A much larger percentage of females is affected in the juvenile form than in the adult. Cantonnet was able to follow 12 cases, varying in age from ten to twenty-nine, none of whom developed diplopia, and no death was recorded.

Clausen (*Oph. Review*, Feb., 1911) reports on a case, a boy, aged 13, of *juvenile tabes with optic atrophy*. He had first been examined four years previously, when he was found to have a bilateral paralysis of the external rectus, and weakness of convergence. Vision at that time was quite normal but he had unequal and immobile pupils. He had a suggestive family history and some personal indications of hereditary syphilis; at that time he was placed upon vigorous inunction treatment, and in a short time his muscular activity was restored, but the pupillary condition remained unaltered. Three years subsequently to his first appearance he was brought again as his sight was failing in the right eye: bilateral atrophy was evident by that time as well as loss of knee jerks and enfeebled Achilles-reaction. The pupils were dilated and did not react, the right eye was completely blind, and the left far advanced in atrophy. In the patient himself and in his mother Wassermann reaction was strongly positive. He also had incontinence of urine more or less all his life; headaches and palpitation,—in fact numerous indications of juvenile tabes. Clausen treated him with "606."

Barkan (*Oph. Year-Book,* p. 366, 1913) reported six cases of infantile and juvenile tabes, the symptoms of which did not differ es-

sentially from those of the adult disorder, and the prognosis of which he regarded as equally gloomy.

Tabes oculaire. (F.) Tabes dorsalis affecting especially the functions of the eye.

Tabes pituitaria. A term applied by Oppenheim to degenerative changes in the lumbar spinal region due to abnormal pituitary secretion. The disease gives rise to a definite syndrome.

Tabit b. Qurra (full name, Abul Hasan Tabit b. Qurra b. Zahrun al-Harrani). This distinguished physician and astronomer was born A. D. 836 at Haran in Mesopotamia and died 901 in Bagdad. Besides a number of works of a general nature, he composed a treatise on ophthalmology entitled, *"On the Seer and the Seeing."* Nothing of this remains today, except a few very short quotations in a work called *"The Light of the Eyes,"* by Salah ad-din, who lived in the 13th century. One of these quoted bits runs as follows: "Let the operation [for cataract] take place on the border of the carpet whereupon thou lettest the patient sleep."—(T. H. S.)

Table for ophthalmic operations. See p. 6051, Vol. VIII of this *Encyclopedia.*

Tablet triturates. TABLETS. TABELLÆ. These are proprietary medicaments for obtaining ophthalmic solutions and are usually made by thoroughly triturating powdered medicines or medicated liquids with finely-powdered sugar of milk or with powdered sugar, moistening the powder with sufficient alcohol to make a paste, and pressing it into moulds consisting of a plate perforated with holes, and then pressing out the tablets by fitting this perforated plate over another plate, upon which are situated pegs that accurately fit the perforations. When the alcohol evaporates and the tablets are dry they are ready for use. These preparations have become very popular within the past few years.

In common with other physicians the ophthalmologist will find the tablet-triturate a very useful form in which to prescribe his remedies. They also suggest other remedial forms for the local application of drugs.

According to the *Extra Pharmacopeia,* in the preparation of tablets the material has first to be granulated, to make it flow easily from the hopper and to prevent it sticking between the dies and punches of the machine. This is effected by moistening it with a little alcohol or water (to which, if desired, a minute quantity of mucilage, diluted about 1 to 4, may be added), rubbing through a suitable sieve (No. 16), and drying thoroughly either by very slight heat, or better, by exposure to the atmospheric air if sufficiently dry

at the time. The decomposition, melting points or volatility of the chemicals to be compressed must be borne in mind. Salol, beta-naphthol, benzoic acid, sulphonal, trional and phenacetin should not be heated.

As they readily dissolve in water they exhibit, like tabloids (q. v.) and *discs* (q. v.) an excellent opportunity of furnishing fresh, aseptic solutions for application to the eye. They can be carried about, either by the surgeon or the patient, to be used when needed without danger of the decomposition and deterioration to which most solutions are exposed.

As an example of the convenience and safety of these medicinal agents is the employment of Schleich's infiltration anesthesia method. It is convenient to have a properly prepared, fresh, sterile solution at hand for intradermal injection. This need is met by the use of tablets, each of which is to be dissolved in 100 c.c. of sterilized water, thus making the necessary infiltration fluid ready for the syringe. As prepared for the market they can be had in three strengths, as follows:

	Strong. 1	Normal. 2	Weak. 3
Cocaine hydrochlor.	0.20	0.10	0.01
Morphia	0.025	0.025	0.005
Sodium chloride	0.20	0.20	0.20

Tablets. See **Tablet triturates.**

Tabloids. Under the trade name of tabloids Burroughs, Welcome & Co. have on sale small disks that are almost instantly (30 seconds) dissolved in the ocular secretions when introduced into the conjunctival sac or applied to the eyeball. Small tinted tubes contain 12 to 25 tabloids and protect them from dust, air and light. If the dose of a whole tabloid is not required it can be dissolved in water and any part of it used as a collyrium. Most of the ordinary drugs used in treatment of diseases of the eye and in determining its refraction are represented in this list.

Tache cérébrale. (F.) A reddish streak produced in several diseases by drawing the nail or any dull-pointed object across the skin surface. It has been observed in exophthalmic goitre.

Tache de Mariotte. (F.) Optic disc; the blind spot.

Tache jaune. (F.) Macula lutea.

Tachiol. Silver fluorid; a salt that has been highly recommended as an antiseptic and substitute for silver nitrate.

Tachistoscope. A name given by Volkmann to a sort of stereoscope in which a falling lid or diaphragm opens for a moment one or both

of the holes through which the observer looks. It is intended to study the time-rate and time conditions of the appearance of objects seen through the openings.

Tachycardia. Excessive pulse rate; one of the cardinal signs of exophthalmic goitre.

Tachycardia strumosa exophthalmica. An obsolete synonym of exophthalmic goitre.

Tachyrhythmia. Tachycardia.

Tachyscope. An apparatus for representing objects in motion. See **Kinetograph.**

Tachytomy. The art of operating quickly.

Tactometer. An instrument resembling a pair of dividers used for the measurement of tactile sensibility. See **Esthesiometer,** p. 4525, Vol. VI of this *Encyclopedia.*

Tænia. See **Tenia.**

T. A. F. Abbreviation for (German) *tuberculin albumose frei,* or albumose-free tuberculin.

Tagliacotian method of blepharoplasty. In 1597 Gaspard Tagliacozzi wrote a treatise on the operation, hence it is sometimes called the Tagliacotian method. It was used by these early surgeons for the restoration of the nose and was performed by removing the integument from the part to be reconstructed and fashioning a skin-flap from some part of the arm or leg and allowing both to granulate. After about three weeks the granulations were freshened and the flap brought into place by binding the limb bearing it securely to the head. When union had been established the pedicle was cut and the limb released. On account of the severity of the operation and the time required to accomplish its object, it fell into disuse for many years, to be revived in 1816 by Carl Ferdinand Graefe, who employed it for restoration of the lids. He modified it by uniting the raw surfaces immediately, instead of waiting for granulation to occur. Even this improvement, which greatly lessened both the inconvenience and time required for healing, failed to make the operation a popular one.

Taie. (F.) Leucoma; spot; scar.

Taillefer, Valve of. See **Valves of the lachrymal canals.**

Tait, Peter Guthrie (1831-1901). Scottish natural philosopher and mathematician, was born in Dalkeith. In 1860 he was elected professor of natural philosophy in Edinburgh University. To mathematical physics he contributed several valuable memoirs, of which those on *Mirage* and on the *Kinetic Theory of Gases,* and those involving quaternionic treatment, call for special mention. In pure mathematics his papers on *Knots* and on *Quaternions* are best known.

In conjunction with Sir W. Thomson (Lord Kelvin), Tait wrote the well-known *Treatise on Natural Philosophy* (1867). *The Unseen Universe,* by Stewart and Tait (1875), and *Paradoxical Philosophy* (1878), a sequel to the former, interest others besides scientific minds. He also published treatises on *Light* (1884), *Heat* (1884), *Properties of Matter* (1885), etc.—(*Standard Encyclopedia.*)

Talbot's law. Of illumination. If a = duration of the flash (as measured by the photometer) and b = the duration of the eclipse, then $\frac{a}{a+b}$ = intensity of the illumination given by a flashing light, taking the steady light as unity.

Talbotype. Calotype. The negative photo process on paper invented by Wm. Henry Fox Talbot.

Taliaferro, William J. A well-known American surgeon and ophthalmologist. Born in Newington, Orange County, Va., in 1795, of Italian extraction, he served in the war of 1812, and received for his military services $700 in prize money and a gold medal from the state of Kentucky. Having attended one year's lectures (in 1818) at the University of Pennsylvania, he settled as general practitioner and ophthalmologist in Washington, Mason Co., Ky. Here he was widely known as an operator for cataract. In 1841 he removed to Cincinnati, where he was made professor of ophthalmology in the Cincinnati College of Medicine and Surgery, and where he lived and practised until his death, Mar. 22, 1871.—(T. H. S.)

Talko, J. A prominent ophthalmologist of Lublin, Russia. He was born in 1839, and died in Dec., 1907, aged 68 years. He wrote no books, but often contributed to the "*Centralblatt für Praktische Augenheilkunde.*"—(T. H. S.)

Tallow. Anciently a scientific, and to the present day a popular, ophthalmic poultice. Tallow was also recommended and used by Dupuytren as an application to the point of a cataract (couching) needle, just prior to its use. The tallow was taken from an ordinary candle.—(T. H. S.)

Tamaquare. A preparation used for clearing opacities of the cornea.

Tamarix gallica. Common (or French) tamarisk, found in southern Europe, northern and tropical Africa, and southern and eastern Asia. The leaves, together with the galls, were, and are occasionally still, used in ophthalmia and hemorrhages.

Tangent. (a) Tangential. (b) A line which touches a curve at a single point. (c) A goniometrical ratio. (d) To bear the relation of a tangent to.

Tangent curtain. A modification by Duane of Bjerrum's screen. See p. 9475, Vol. XII of this *Encyclopedia.*

Tangential law. See **Law, Brewster's**, p. 7023, Vol. IX of this *Encyclopedia.*

Tangent scale, Maddox. See **Scale, Maddox tangent.**

Tangible arithmetic. The types of numerals devised for teaching the blind this science.

Tangible print. See **Alphabets and literature for the blind,** p. 249, Vol. I of this *Encyclopedia.*

Tannal. Aluminum tannate.

Tannalbin. Exsiccated tannin albuminate; a patented reddish-brown powder prepared from tannin and albumin; an astringent in trachoma, catarrh of the bowels, diarrheas, etc.

Tannic acid. See **Tannin.**

Tannin. TANNIC ACID GALLOTANNIC ACID. DIGALLIC ACID. $C_{14}H_{10}A_9$. This drug is an organic acid obtained from nutgalls. It is a shiny, faintly yellow, amorphous, bulky powder, odorless but with an astringent taste. Very soluble in water, glycerine and alcohol.

This is an astringent agent that is comparatively little used because of its irritating action and because it has been supplanted by more efficient remedies. As the glycerine of tannin interest in it was, some years ago, revived for painting the granulations of trachoma. In simple, chronic conjunctivitis with thickening of the membrane Michel advised its application as an ointment, 1:30, in petrolatum. Fick prescribed a watery solution of the same strength, to be used as a collyrium under the same circumstances, while other writers have regarded it with favor in diseases of the conjunctiva with undue secretion of pus or muco-pus. In the chronic forms of conjunctivitis A. C. Rogers preferred the following combination: Acid. boric, gr. xv; Acid. tannic., gr. i; Glycerin., fl ʒi; Aquæ camph., fl ℥i.

Byron B. Viets used this remedy in solutions of 80 grains to the ounce, which he also gave to patients suffering from trachoma. He advised that a few drops of a weak solution of cocain be distilled into the eye before using the tannin.

Tannin, Glycerite of. See **Glycerite of tannin,** p. 5593, Vol. VII of this *Encyclopedia.*

Tantalum. One of rare metals said to combine, for commercial purposes, the qualities of steel and platinum. It is silver-white and associated with columbium in columbite. Although quite ductile it becomes hard under the hammer. It forms alloys with iron and tungsten and is chiefly used for filaments in lamps, some of them employed in medical and surgical instruments.

Tape measurement of squint. See p. 8105, Vol. XI, as well as under the sub-head, *Holzer's modification, of strabismus,* in this *Encyclopedia.*

Tapetum. In comparative ophthalmology (q. v.) the brilliant, iridescent and generally highly colored choroido-retinal membrane that reflects the light from the fundus of many of the lower animals. It is represented in man by the so-called *intermediate layer* of the choroid.

Tapetum cellulosum. The iridescent layer in the choriocapillary layer of the choroid of carnivorous animals, giving the peculiar luster seen in the eyes of those animals. See **Comparative ophthalmology.**

Tapetum choroideæ. See **Tapetum lucidum.**

Tapetum fibrosum. The intermediate part of the stroma layer of the choroid of certain animals, as the cow, sheep, and horse, containing wavy bundles of connective tissue, which cause the metallic glow sometimes seen in such eyes. See **Comparative ophthalmology.**

Tapetum lucidum. The iridescent pigment epithelium of the choroid of cats and certain other animals, which give their eyes the properties of shining in the dark.

Tapetum nigrum. The external, or pigmentary, layer of the retina.

Tapetum oculi. The pigment layer of the retina.

Tapeworm. A parasitic intestinal cestode worm, or species of a flattened, tape-like form, and composed of separate joints. Those infesting man are principally of the genera *Tenia Bothriocephalus,* and *Hymenolepis.* The ova of tapeworms are taken into the alimentary canal of the host, whence they make their way into the tissues, where they form small, cyst-like masses, called *scolices* or *cysticerci.* See **Hyatid,** p. 6073, Vol. VIII of this *Encyclopedia.* When the flesh of the original host is eaten, the scolices develop within the alimentary canal of the new host into a *strobilus,* or adult tapeworm, which consists of a head, neck, and a variable (often very great) number of oblong joints, or segments, called *proglottides,* each of which is hermaphroditic and produces ova. See, also, **Tenia.**

Tapis. (F.) Tapetum choroideæ.

Tar. Pix liquida. Resina empyreumatica liquida. Bitumen. Asphalt. This well-known agent is obtained by the destructive distillation of various pine woods. In modified forms it also occurs as a natural deposit in various parts of the world. It is a thick, viscid, semifluid, black-brown mass with an unpleasant odor and sharp, bitter taste. Tar is a variable and complex organization containing acetone, acetic acid, phenol, methyl alcohol, cresol, etc.

In the form of ointment it is used in squamous blepharitis and other dermal affections of the lids. One of the best formulas is that with white precipitate: Hydrarg. precip. alb., 0.5 (gr. viiss); Petrolati, 2.0 (ʒ ss); Picis liquidæ, 8.0 (ʒii).

Both the *vapor and dust of tars* are irritating to the eyes. Truc and Fleig (*Archives d'Ophtl.*, Sept., 1913, abs. *Oph. Review*, p. 174, June, 1914), have described a number of clinical observations as well as experimental work on rabbits and dogs. Two human cases are detailed in both of which severe conjunctivitis and keratitis appeared after working at the unloading of a cargo of bitumen (asphalt). In both the trouble appeared as soon as they left off work and were exposed to bright light. Both patients had previously suffered from watery eyes. The authors advise that men with any previous ocular irritability should not be employed at this work, and that in all cases the face should be carefully washed before exposure to bright light. The experimental work was conducted on rabbits and dogs. In one series of experiments powdered bitumen pure and mixed with inert powders or road dust was introduced into the eye and in a second series the animals were exposed to bituminous vapors. The latter series showed only a mild conjunctivitis which rapidly ceased when the vapor was withdrawn.

The authors draw the following conclusions:

1. Bituminous dust can produce in man lesions of the conjunctiva, interstitial keratitis, ulcerative keratitis, hypopyon and iritis with great rapidity; the majority of these lesions rapidly heal, but leave more or less extensive leucomata.

2. The antecedent condition of the eyes seems to constitute an important predisposing cause, and the action of solar light an assisting or occasional cause which must be taken into account from the prophylactic point of view.

3. The experimental action of bituminous powders in the rabbit produces a blepharo-conjunctivitis, at first of a mucous type, later becoming purulent, interstitial keratitis with persistent leucomata. ulcerative keratitis, episcleritis and iritis. In the dog similar lesions occur but of a less severe type (the quantity of dust that reached the eye being less). The anatomical disposition of the corneal lesions was the same as in the human subject, i. e., in a horizontal line corresponding to the palpebral fissure.

4. Mixtures of bituminous dust with inert and non-septic powders are less active than the pure powder. On the contrary mixtures with ordinary road dust produce more rapid and severe lesions.

5. As in the case of tar dust the mode of action of bituminous dust

shows a mechanical, a microbic and a chemical factor; the last is always the preponderating one, the two others have a variable importance according to the nature of the dust (pure bitumen or not) and method of production.

Roche (*Ann. d'Oculistique,* Nov., 1911), reports the case of a workman who was hit in the face with a mass of Norway tar so violently that he was thrown down and rendered almost unconscious. Six hours later, he had extreme photophobia, and the conjunctivæ were found much reddened. There were traces of tar in the lower culs-de-sac, and the corneæ were black, with a layer of tar which extended to the limbus of each eye. The tar was removed with a cataract curette, leaving the corneæ normal except for slight dullness. Next day the conjunctivæ were still red but the corneæ were normal. The patient complained of photophobia and headache. These symptoms persisted for rather a long time, but at the end of a month the man was able to resume his work.

Taraxis. (Obs.) A disorder of sight arising from a blow or from compression of the eye; also, a mild ophthalmia.

Target practice, Ocular relations of. See **Markmanship, Ocular relations of,** p. 7599, Vol. X of this *Encyclopedia;* also **Sport.**

Tarsadenitis. An inflammation of the tarsus of the eyelid and of the Meibomian glands.

Tarsal arch. The vessels that pass from the outer and inner angles of the eye form the tarsal arch—along the edge of the lid.

Tarsal conjunctiva. Conjunctiva of the eyelid.

Tarsal conjunctivitis. Palpebral conjunctivitis.

Tarsal cyst. See **Chalazion,** p. 983, Vol. III of this *Encyclopedia.*

Tarsal cyst knife. A number of these instruments especially devised for the removal of chalazion (q. v.) have already been pictured in

McGillivray's Tarsal Cyst Knife and Sharp Steel Spoon.

this work. McGillivray's *combined knife and curet* is shown in this text. See the figure.

McHardy's Tarsal Cyst Knife and Sharp Steel Spoon.

McHardy's tarsal cyst and knife combination is also shown in the figure.

Tarsal glands. See **Meibomian glands.**

Tarsal plate. The tarsus; the incorrectly named tarsal cartilage.

Tarsal tumor. A synonym of chalazion (q. v.).

Tarse. (F.) The tarsal plate, or tarsus.

Tarsectomy. EXTIRPATION OF THE TARSUS. RESECTION OF THE TARSUS. Excision or other removal of a portion or all the tarsal plate. The operation is sometimes, though incorrectly, termed *tarsotomy.*

The tarsus is removed either in part or in whole mainly for the relief of distortions of the lid *(entropion, ectropion)* or for diseases that directly involve it—especially for *trachoma* (q. v.). See for steps of the various tarsectomies under **Trachoma,** as well as p. 4377, Vol. VI of this *Encyclopedia.*

Tarsen. Pertaining to the tarsus.

Tarsitis. Inflammation of the tarsus (the so-called tarsal cartilage) is characterized by great thickening of the lid-margin, often producing considerable deformity. It occurs chiefly in syphilitics as a tertiary symptom. Acute tarsitis is associated with conjunctivitis, blepharitis, and sloughing of the tissues, and is met with in scrofulous (i. e., tuberculous) subjects. The upper lid, when affected, droops from its increased weight; when in the lower lid ectropion frequently results. The treatment includes the appropriate treatment for blepharitis with yellow oxide of mercury ointment, and appropriate internal (anti-syphilitic, etc.) remedies. See, also, **Tarsitis syphilitica.**

Prevedi (*Archivio di Ottalmologia,* 21, p. 482, 1915), describes a *granulomatous tarsitis* with diffuse degeneration, found at the autopsy on a child 20 days old. A swelling the size of a grain of wheat was found near the middle of the right lower lid. Microscopically it had the appearance of an inflammatory focus of infiltration. After excluding chalazion and gumma, the writer concluded that the infiltration was tuberculous in character, this diagnosis being supported by the presence of giant cells in a focus of softening; and of caseous degeneration. No tubercle bacilli could be discovered.

Tarsitis necroticans. Under this caption Jarnatowski of Posen (see abst. in *Ophthalm. Review,* p. 262, Sept., 1913) has reported the case of a man of twenty who came on account of a smarting pain in the left eye. He gave no history of illness, and there were no signs of any constitutional disease.

The left upper lid was swollen and drooping, especially in the outer half. The ocular conjunctiva was normal, and there was no increased secretion. The upper lid could be everted without causing pain, and on this being done the conjunctiva was found normal in appearance

over the outer and inner thirds, but over the middle third extending the whole length of the tarsus there was a raised, yellow-colored ridge from 2 to 3 mm. broad by 10 mm. long, bordered by inflamed conjunctiva which gradually passed into the normal conjunctiva on each side. The surface was smooth and the swelling had a firm consistency. No discharge was present. This slough was too adherent to be removed with cotton, but was easily removed with forceps, leaving a cavity behind. No bleeding followed its removal. The cavity was scraped and filled with iodoform after which cicatrization rapidly followed.

On microscopical examination of the portion removed it was found to consist of the tarsus and remains of the Meibomian glands. In only a few places was there any small-celled infiltration or evidence of any attempt at absorption of the tissue. The section consisted mainly of bundles of fibrous tissue, and there was very little inflammatory change. Even after prolonged staining the tissue failed to take the color well and the outlines of cells and fibres remained indistinct. In the middle of the necrotic fibrous tissue oval spaces corresponding to the acini of the Meibomian glands were visible, either empty or filled with fat droplets and remains of the glandular cells.

Bacteriological examination showed but few microorganisms, chiefly staphylococcus aureus.

This case appears to belong to a rare group of cases of which four have already been described by Mitvalsky and is really due to an infection with staphylococcus aureus of so acute a nature as to cause necrosis of the Meibomian glands and investing tarsus with practically no antecedent inflammation. In general, infection of the Meibomian glands by this organism leads to the common suppuration known as *hordeolum internum.* Occasionally, however, the infection is more severe and takes the form described by Natanson *(polyadenitis meibomiana chronica suppurativa)* in which a number of glands are infected and in which some necrosis of the neighboring tissue takes place.

Tarsitis syphilitica. The ordinary form of *tarsitis* (q. v.) See, also, **Syphilis of the eye.** In this form of the disease the lid is so much enlarged that it cannot be everted and so indurated that when incised it does not bleed. Hyaline degeneration of the connective tissue with a few nucleated cells are usually found. The small arteries and the other vessels show (but the veins least) hyaline metamorphosis, thickening of the adventitia and an approach to endarteritis proliferans. Calcareous deposits are sometimes found and in a case of long (seven years) duration the overlying epithelium assumed the appearance of epidermis.

A. C. Sauter (*Annals of Ophthalm.*, Oct., 1911) gives a good account of luetic tarsitis and of a case successfully treated by salvarsan. He notes that this condition manifests itself as either a diffuse gummatous infiltration with well-marked inflammatory symptoms, or more commonly as a circumscribed non-inflammatory gummatous formation. Generally it is characterized by single or multiple nodular swellings of cartilaginous hardness which vary in size from that of a pea to a small pigeon's egg. The skin and conjunctiva may be but slightly affected, and palpation shows the enlargement to be confined solely to the tarsus. Occasionally these gummatous nodules break down and ulcerate. The formation of cicatrices and malpositions of the lid may ensue. The diffuse gummatous infiltration causes a diffuse enlargement of the lid with the cardinal symptoms of inflammation.

As noted above, an incision in a tarsal gumma does not bleed.

In 1899 Hermann was able to collect but 20 cases in the literature of syphilitic tarsitis. The writer's case was that of a young colored man who developed a tarsitis three months after the primary lesion. The syphilis ran a malignant course. Treatment with mercury by inunction seemed to have but little effect upon the disease, either locally or constitutionally. The first lid tumor was in the left lower lid. This disappeared under the use of a lotion and ointment. About a month later he developed a slight diffuse swelling and redness of the left upper lid. The skin was movable over the tarsus, and slight pain and tenderness were present. Several shallow ulcerations appeared on the outer tarsal conjunctiva interspersed among a few grayish-white subconjunctival striæ. The ocular and palpebral conjunctiva was moderately injected, and associated with a slight discharge. The left pre-auricular glands were much enlarged.

During the next few weeks no improvement was made under local washes and calomel dusting powder and mercurial inunctions. About this time a localized nodular swelling appeared in the right lower lid with a grayish patch on the conjunctiva. The left upper lid became more swollen, and a large swelling appeared in the region of the parotid gland with central fluctuation. During the next two weeks the right lower lid improved but no improvement followed in the left upper lid. This state of affairs continued with exaggeration of symptoms in the right lower lid, when he was given an intravenous injection of salvarsan. Very rapid improvement followed. The general papular eruption and the lid symptoms made marked progress toward recovery in one week, and a syphilide of the scalp healed.

Tarsocheiloplasty. A plastic operation upon the edge of the eyelid, as in trichiasis.

Tarsodialysis. A name for canthotomy. See p. 1385, Vol. II of this *Encyclopedia.*

Tarsoleptinsis. Thinning of the tarsus—an operation for the relief of entropion and trichiasis. See p. 4379, Vol. VI of this *Encyclopedia.*

Tarsomalacia. Softening of the palpebral "cartilages."

Tarso-orbital. Pertaining to the tarsus and the walls of the orbit.

Tarso-orbital fascia. A sheet or membrane of fibrous tissue which connects the lids with the margin of the orbits and shuts off communication between the connective-tissue space of the lids and the orbital cavity. It is attached to the orbital margin, usually to its inner lip, especially on the upper and lower margin, and is intimately connected with the periosteum on the one hand and the capsule of the eyeball on the other; also, at the canthi, with the internal and external or canthal ligaments, extending behind the latter to the canthi. It is prolonged to the upper border of the tarsi of the upper lids and the lower border of the tarsi of the lower lids, where it is firmly united.—(Foster.) See, also, **Anatomy of the eye,** as well as **Blepharoplasty.**

Tarsophyma. (L.) (Obs.) A swelling of the tarsal cartilages.

Tarsoplasia. Same as **Tarsoplasty.**

Tarsoplasty. Plastic surgery of the tarsus. Operations of this class mark a distinct improvement in the treatment of cicatricial entropion, especially in cases where the tarsus is thickened and incurved.

The objection that by excision of a piece of the tarsus, as part of the procedure, the lid is shortened is not valid in most cases, inasmuch as the amount usually removed, a strip at most 2 or 3 mm. wide, cannot effect shortening to any serious extent. Furthermore, in just the cases where it is indicated, there is frequently a mild degree of ptosis, so that the slight shortening that might result would be beneficial than otherwise.

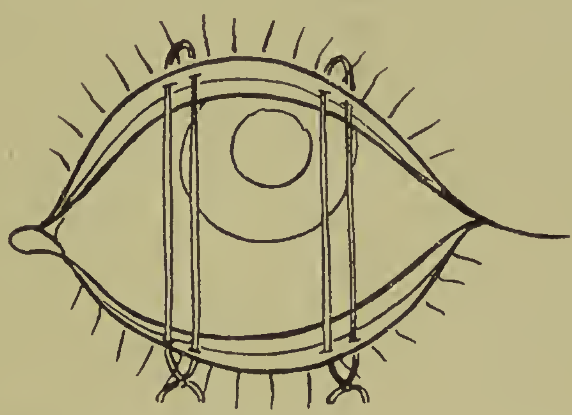
The criticism that section or resection of the tarsus disturbs the Meibomian glands, or even destroys them, is hardly a reasonable objection, for in the class of cases in which this treatment is applicable, the glands are probably to a great extent atrophied or obliterated owing to the contraction of the tarsus, as pointed out by Hotz.—(W. H. W.) See, also, **Entropion.**

Tarsorrhaphy. Any operation for shortening and narrowing the palpebral fissure. See p. 1048, Vol. II; as well as under **Lagophthalmia,** p. 6992, Vol. IX of this *Encyclopedia.*

Ernest Thomson (*Ophthalmoscope,* p. 301, May, 1914) reviews the operation of Bishop Harman (*Lancet,* Feb. 7, 1914) for lessening the *"obviousness" of the artificial eye* in those patients who possess a wide

palpebral fissure, a type of fissure which exposes the articial eye so much more than does the narrow type.

Essentially the operation is tarsorrhaphy, but this is performed in a special manner. To obviate the well-known difficulty caused by the frenum at the outer canthus, the author has devised a special clamp, the blades of which are diamond-shaped and the under blade of which is notched, so as to accommodate the frenum. By means of this, when the extremity of it is 5 mm. beyond the canthus, as much as 12 mm. of each lid is framed by the clamp. It is then easy to incise the intermarginal space, with a bent Jaeger keratome for choice, and to separate the lids into the eyelash-bearing layer and the conjunctival layer. With a single double-needled thread, the two skin layers are united at two points, a length of drainage tubing being interposed on each



Method of Placing Stitches for Temporary Tarsorrhaphy (Pissarello).

lid in such a manner that the sutures are passed through, not merely over, the tubing. It is better to aim at doing too much rather than too little, since the former can be rectified in a day or two. The dressing and the ligature are removed on the fourth day, and the shell previously worn is slipped in. If too much has been done this can be remedied by dragging the lids apart a little. In judging the effect, allowance must be made for a slight apparent excess, caused by the swelling of the lids consequent on the operation and the four days' bandaging.

A modification of the usual operation is given by A. Elschnig (*Zeitschr. f. Augenheilk.*, 33, p. 280, 1915), who performs it under local anesthesia with 2 per cent. cocain or novocain solution and adrenalin. After insertion of Jaeger's spatula the intermarginal section is made to the extent of the intended shortening, and the medial end of the conjunctival plate is incised for from 3 to 4 mm. vertically to the lid border. In this depth both plates of the lid are separated

in the intermarginal section up to and under the external canthus. The inner portion of the external plate, with preservation of the lashes, and the internal plate, in its whole width, are pared. In the same fashion the upper lid is split into two plates. Then the free corner of the inner plate of the upper lid is grasped with toothed forceps and by a cut, first parallel to the lid border, then turning downward in form of an arc as far as and under the external canthus, the triangular piece of the inner lid plate, thus circumcized, is entirely removed. Hence a triangular defect of the inner plate of the upper lid results whose apex lies under the external canthus, and whose small base is formed by the lateral edge of the intact inner plate. After paring the external plate up to the canthus in the same way as in the lower lid, the inner plate of the lower lid is drawn into the defect by a double armed loop; 2 mm. from the pared margin of the prepared inner plate of the lower lid both needles are successively inserted from the conjunctival surface and from behind pushed out about 4 mm. above the row of the lashes of the upper lid. The thread is at first drawn slightly and, after uniting both external plates by two or three sutures, it is tied over a piece of gauze.

To produce temporary closure of the lids for various purposes Pissarello (*Oph. Year-Book,* p. 300, 1916) describes the operation illustrated in the accompanying figure and records a series of cases of lagophthalmos and exophthalmos, from various causes, and ectropion, for which this operation is resorted to. The stitches are allowed to remain in some cases ten or fifteen days.

Tarsotomy. The operation of incising the tarsus. See p. 4372, Vol. VI of this *Encyclopedia.* Sometimes this term is incorrectly used in the sense of *tarsectomy* or removal of a portion or all of the tarsus.

Tarsus. The tarsal plate (so-called "cartilage") of the eyelid which forms the skeleton or support of the lid. It is mostly dense connective tissue, interspersed with numerous elliptical nuclei. The one in the upper lid is much thicker, broader, and denser than that in the lower lid. Its shape is crescentic, with the ciliary border sharply cut off. The tarsi become thinned toward the orbital margin, and finally merge in a fascia, which is firmly attached to the orbital margin. The tarsus contains the Meibomian glands. See, also, p. 348, Vol. I of this *Encyclopedia.*

Tarsus, Amyloid degeneration of the. This is a very rare disease (except insofar as the alteration occurs with gumma of the tarsus). Steiner (*Annales d'Oculistique,* Dec., 1900) reports four cases in natives of Java. In one case the right upper and lower eyelids were the seat of a large hard tumor, apparently involving all the tissues of

the lids save the skin. Owing to the swellings the upper lids could not be voluntarily raised nor could either of them be everted by the surgeon; but between them could be discerned an abundance of yellowish-red granulations upon the palpebral conjunctiva. The cornea was in a condition of advanced pannus, and the left eye was trachomatous. Regarding the case as one of malignant disease of the lids, and the right eye having lost all useful vision, the author removed the lids with the tumors, and enucleated the eye. He was surprised, however, afterwards to find on examination, that instead of sarcoma or carcinoma which he had anticipated, the lid masses showed a homogeneous appearance, almost without structure and devoid of cells, and distinctly exhibiting the reaction of amyloid degeneration.

In the second case the upper lid of each eye displayed the same condition, the lower lids not being involved. The appearances as to the lids and palpebral conjunctiva were almost identical in each eye; but in the left the cornea was ulcerated, and vision reduced to hand-movements, the vision in the R.E. being $^6/_{24}$. The following operative procedures were carried out. On the right side the skin was horizontally divided 3 mm. from the ciliary border and the tumor removed, leaving, however, a thin layer which rested upon the conjunctiva. On the left side, owing to the extensive destruction of the conjunctiva, the whole of the lid with the tumor was removed, only preserving the ciliary border, which, together with the redundance of skin resulting from the extension of it by the growth, served to form a new lid of sufficient thickness. The result was satisfactory. The lids relieved of their growths could again be raised, and the patient was able to open his eyes without difficulty. The masses on subsequent examination showed the characteristic reaction of amyloid degeneration.

In the third case the patient had had "bad eyes" for many years. During the last two a tumor had formed upon the right upper lid which had prevented him from voluntarily raising it. The growth was hard to the touch, suggesting the consistence of cartilage; eversion was impossible. The conjunctiva was trachomatous, the cornea partly in a condition of pannus. An operation for removal of the growth was carried out, similar to that described above. The mass on section showed partial calcification, and the reaction of amyloid degeneration was readily obtained.

In the fourth case a tumor of cartilaginous hardness occupied the lower lid. Differing from the preceding cases its surface was nodular; the conjunctiva was congested and somewhat swollen; the palpebral surface of the upper lid showed signs of antecedent trachoma; the cornea was intact. The R. E. was healthy. The growth was removed.

with a satisfactory result. On section the mass responded to the test for amyloid degeneration, though in a less marked degree than that exhibited by the other cases, owing, as the author believed, to the degenerative process being in a less advanced stage. The author points out that while this disease of the tarsus is practically unknown in Europe, Malays are particularly exposed to it, because, as he believes, of the prevalence among them of severe forms of trachoma, which constitutes by far the commonest ocular disease to which they are subject. Amyloid degeneration of the tarsus is purely a local affection, not depending upon any cachexia, and occurring in otherwise perfectly healthy individuals, in whom no evidence exists of amyloid degeneration elsewhere in the body.

Tarsus, Excision of the. See **Tarsectomy.**

Tarsus, Hypertrophy of the. See **Tarsitis.**

Tarsus, Incurving of the. See **Entropion.**

Tarsus, Inflammation of the. See **Tarsitis.**

Tarsus, Removal of the. See **Tarsectomy.**

Tarsus, Resection of the. See **Tarsectomy.**

Tarsus, Sarcoma of the. An example of this exceedingly rare neoplasm is recorded by Prout (*Archives of Ophthalm.*, Vol. 8) in which the conjunctiva was involved and amyloid degeneration was also present.

Tarsus, Tuberculosis of the. This is a very rare infection, probably always due to extension from the conjunctiva.

Tartaro. A one-eyed giant of Basque mythology. Though the son of a king, he was a dullard and a cannibal. Having failed in all his enterprises, he committed suicide by drowning.—(T. H. S.)

Tartra, A. E. A French surgeon, who seems to have devoted considerable attention to ophthalmology. Born about 1775, he received his surgical degree at Paris in 1802. In 1812 he wrote *"De l'Opération de la Cataracte,"* in unsuccessful competition for a professorship. He died in 1840.—(T. H. S.)

Taruolo. (It.) Chancre.

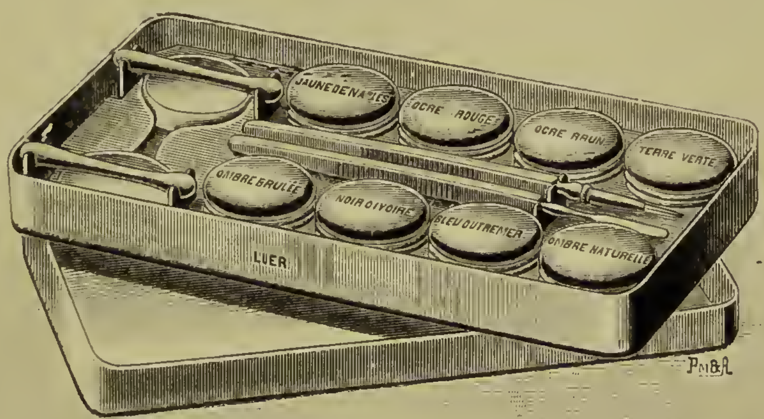
Tattooing colors. As shown in the figure, the Chevallereux and Polack tattooing case contains a series of eight colors, two mixing saucers, 2 glass rods, a spatula and a tattooing needle.

Tattooing needles. See p. 3478, Vol. V of this *Encyclopedia.*

Tattooing of the lid skin. Accidental tattooing of the eyelids, chiefly by grains of powder, is a comparatively common occurrence. In recent cases of powder-burn the best results are obtained by placing the patient under a general anesthetic and using a nail-brush under aseptic precautions. If seen after the carbonized particles

have stained the integument, puncture with the electrolytic needle will give satisfactory results, although the treatment is tedious.—(J. M. B.) See, also, **Injuries of the eye.**

Tattooing the cornea and conjunctiva. See p. 3473, Vol. V of this *Encyclopedia.* Attention is drawn to the method of Shanker (*Oph. Year-Book*, p. 120, 1916) who separates the conjunctiva all around the sclero-corneal margin, undermining it, and then stitches the edges together over the cornea so as to completely cover it. Lamp black, obtained by burning a castor oil lamp and collecting the deposit, is then tattooed into the conjunctiva or injected as an emulsion subconjunctivally, or placed over the opacity first and the conjunctiva then stitched. If there is a large staphyloma, it may be excised, the cut margins of the sclera stitched with catgut and the con-



Chevallereau and Polack's Metal Case with Saucers, for Color-tattooing of the Cornea.

junctiva stitched over that. The color deepens as time goes on, as the conjunctiva gets more and more adherent, the redness passes off and the transparency of the conjunctiva is again restored. Pigmentation lasts much longer than after tattooing the cornea.

Streiff (*Klin. Monatsbl. f. Augenheilk.*, Feb.-Mar. 1915, p. 184,) mentions a case in which, owing to an acid burn, the cornea of the left eye had become opaque and covered by conjunctival overgrowth. An attempt to make a black pupil by removing some epithelium and rubbing ink into the raw surface failed on account of the opacity of the resulting scar tissue. Subsequently the conjunctiva was undermined in the centre and ink introduced beneath it, producing a fairly black pupil. The appearance of a limbus was then produced by introducing a carefully prepared sterilized silk thread saturated with Indian ink around the corneal margin beneath the conjunctiva. On

withdrawing the thread the ink remained in its track, producing a satisfactory limbus-like outline. See, also, the other **Tattooing** headings.

Tattooing shield. This simple device, the invention of Armaignac, is intended to limit the action of the tattooing instrument to the cornea or to the area on the eyeball which is to be colored.

Tattooing Shield for the Cornea. (Armaignac.)

Tatuaggio della cornea. (It.) Tattooing the cornea.

Tavignot, François Louis. A distinguished Parisian ophthalmologist. Born at Paris in 1818, he studied his profession in that city and from 1842-45 was assistant in the eye clinic at La Pitié. He became a distinguished operator and ophthalmographer. Late in life he retired, and then lived very quietly for many years. The date of his death is not procurable.

The list of his journal articles is a very long one, and most of them were published in the *"Annales d'Oculistique,"* beginning in 1843. His larger writings are as follows: 1. *Quelques Remarques sur les Cataractes Secondaires.* (Paris, 1843.) 2. *Traité Clinique sur les Maladies des Yeux.* (Paris, 1847.) 3. *Etudes Cliniques sur les Maladies de la Cornée.* (Paris, 1854.) 4. *Mémoires Pratiques sur les Maladies des Yeux.* (Paris, 1857.)—(T. H. S.)

Taylor, Charles Bell. An eccentric but prominent and very able ophthalmologist, of Nottingham, England. Born in 1829 at Nottingham, where his father and brother were veterinary surgeons, he studied in Edinburgh and Paris and was at first a psychiatrist. Later he turned his attention to diseases of the heart and lungs, and, finally, became an ophthalmologist. In 1859 he was elected surgeon to the New Nottingham and Midland Eye Infirmary, and his reputation as an ophthalmologist was soon world wide.

Concerning Taylor as an operator and also as a man, we cite *verbatim* the following interesting passage from *"The Ophthalmoscope"* for May, 1909: "As an operator he was unsurpassed. His dexterity in removing cataract was really wonderful. The darkened chamber (Taylor invariably operated by the concentrated light of a paraffin lamp), the impassive surgeon, the placid patient, and the absolute silence—all went to complete a picture that once seen could never be

forgotten. His only assistant was a man-servant, who had been in Taylor's employment for many years. In many respects Taylor, who never married, was a remarkable man. His personality was most impressive—tall, with piercing black eyes and determined mouth; small wonder that so striking an appearance impressed those who came into contact with him. Bell Taylor's reputation among the public was even greater than among his professional brethren, to whom much offense had been given by his attitude upon controversial matters, such as the Contagious Disease Act, vaccination, and vivisection. He took a prominent and professionally unpopular part in securing the repeal of the Contagious Disease Act; he was a determined opponent of vivisection, which he held as useless as it was inhumane; and he set his face sternly against anything like compulsory vaccination. Unorthodox and unconventional Taylor undoubtedly was, and that rendered him less popular among his medical brethren than would otherwise have been the case. At the same time, he was an ophthalmic surgeon of exceptional skill, especially from the operative side, and he possessed much humor and even more humanity, as many a poor denizen of Nottingham and its neighborhood can testify. Some of his eccentricities were well described by the late Col. Anstruther Thomson, Master of Pytchley, in his *'Eighty Years Reminiscences.'* In 1886 he had to consult Bell Taylor, and found the rooms and passages in his house in Park Row, Nottingham, crowded with patients. 'Bell Taylor,' he continued, 'was a most amusing and eccentric man. He lived about four miles out of town. In the morning he breakfasted on porridge and treacle, walked about his garden, composing medical lectures or political papers. (He was a keen Conservative.) He then mounted a tricycle and rode into Nottingham. He had about thirty tricycles and bicycles in his coach houses. He had a small wooden house at the top of the hill, where he left his bike, got into a cab, and went to his hospital—I think he had two or three houses with patients—and then to his rooms, which were full. He had lunch at three o'clock in the kitchen, which was prettily got up with colored glass and tiles, and had two nice white horses in loose boxes close by with looking glasses so that they could see themselves. He used to come and sit with me about ten o'clock. I said, 'Have you had a busy day?' 'I have seen a hundred and ten fellows and operated ten times.' At eleven o'clock he mounted his bike, and rode home to his country house.''

Dr. Taylor died at his home, Beechwood Hall, Mapperly Park, Nottingham, April 13, 1909, of influenza, aged 80 years, leaving an estate valued at £160,000. Even in his will, his eccentricity and also

his kindness to animals were prominently exhibited. Thus, he left £5,000 each to the British Union for the Abolition of Vivisection, to the London Anti-Vivisection Society, to the British Committee of the Internation Federation for the Abolition of the State Regulation of Vice, to the National Anti-Vaccination League, and to the Royal Society for the Prevention of Cruelty to Animals. Ample provision was also made for the keeping of all his animals in comfort "so long as they might live."—(T. H. S.)

Taylor, John. He was also called "Chevalier Taylor." A skilful ophthalmologist, he was, at the same time, one of the most remarkable quacks in history. Born at Norwich, England, Oct. 13, 1708,* he was at first apprenticed to a London apothecary. Later he studied with Cheselden in London and with Boerhaave in Leyden. He then proceeded to Paris where his wandering, loud-mouthed career as "the greatest ophthalmologist of all time" began.

From Paris he went to Marseilles, and, soon after, was elected a Fellow of the Medical Faculty of the University of Basel. About this time it was, apparently, that he invented, or devised, his celebrated coach, in which he constantly rode about, either in city or in country. It was a very pretentious affair, painted all over with great eyes, and presenting the glaring inscription, "Qui visum dat, dat vitam." With handbills and with music, with glittering coach and public harangues, he conferred the inestimable benefits of his condescending presence on all the important cities and many of the country towns of Europe. He even permitted his light to shine on the continent of Asia.

Here is a specimen handbill of this much too liberal worthy: "*Northampton, Saturday, Dec.*, 19. Tomorrow being *Sunday*, the 20th, (as usual on that day)—the Gentlemen,—the Ladies,—the Clergy, and all of Literature and Distinction, are hereby invited,—at six in the evening, at the Great Room, at the *Red-Lyon*, to a *Phisico-Theological Declamation* in Praise of Sight,—design'd both in speaking and action, agreeable to the Rules of ORATORY—The SYLLABUS,—will be given free to all present, and the whole will be free.—by John TAYLOR.—Doctor of Physic—Oculist to the King of GREAT BRITAIN—Fellow of several colleges of Physicians, etc. being a Specimen of a Course many Years given in the several Universities, and the several Courts Abroad,—*London, Edinburgh*—and

* So, at least, according to Pagel and also according to Hirschberg. According, however, to Dr. Mortimer Frank, in an article entitled "John Taylor, the Charlatan Oculist" (an article to which, in other matters, I am very deeply indebted, and which appeared in the *Annals of Ophthalmology* for 1905) the date should be Aug. 16, 1703.

lately at *Dublin*. The GENTRY are invited every morning to see his METHOD of *restoring* Sight, etc.—at six on *Monday* evening next (the 21st instant) he will certainly give the Lecture on the Alterations of the EYE, etc.—when the Eye will be dissected, and all its various Beauties displayed, in the Order of a Work lately published in Octavo, with plates, at EDINBURGH. Notwithstanding the Many who usually attend on this Occasion, the ROOM will be so regulated that every Person present may see the several Parts of the EYE accurately examin'd."

Here is a portion of an address which this rhapsodical ophthalmologist delivered before the students of Oxford University: "The eye—most illustrious of the muses, most learned Oxonians, whose fame I have heard celebrated in all parts of the globe—the eye, that most amazing, that stupendous, that comprehending, that incomprehensible, that miraculous organ, the eye, is the Proteus of the passions, the herald of the mind, the interpreter of the heart, and the window of the soul. The eye has dominion over all things. The world was made for the eye, and the eye for the world.

"My subject is Light, most illustrious sons of literature—intellectual light. Ah! my philosophical, metaphysical, my classical, mathematical, mechanical, my theological, my critical audience, my subject is the eye. You are the eye of England.

"The eye is the husband of the soul!

"The eye is indefatigable. The eye is an angelic faculty.

"The eye in this respect is a female. The eye is never tired of seeing; that is, of taking in, assimilating, and enjoying all Nature's vigor.

"The eye is the Orator of Nature, and talks the language of the Universe, of all beneath the moon, of all above it. It talks the language of Heaven, too; it renders useless all sounds except the tender moanings of lovers, those turtle cooings of desire, those nameless throbbings of fruition; these are the genuine dictates of the broken raptures of the soul, which she scorns to shape into words; nor can she lose time in so base a labor.

"We owe the ladies to the eye, those transcripts of the angels, those specimens of future bliss, those fountains of Joy, those dainties of desire, those cordials of all human care, who people the earth with their energy, and the sky with inhabitants; these patterns of purity and love, these masterpieces, these lucky hits of Heaven, are the finest regale for the eye of man, where it feasts on the ruby of the lips, the vermillion of the cheek, the snow of the forehead, and the cherub in the eye; and yet even these are but the signs, the invita-

tion as held out of that ecstatic, that soul absorbing—but language is too weak.''

In 1735 we learn of his being in Liége and Cologne. In 1736-7 he abandoned his Bedouin ways sufficiently to permit of his passing somewhat more than one whole year of continuous residence in England. The result of these twelve months of impudence and brass was an appointment as oculist to King George II. In 1738 he appeared in Portugal, where his English honors were worked to great advantage. In 1740 he quacked his way about in Austria, and, from '41 to '44, in England again. In 1744 he lectured on ophthalmology at the University of Edinburgh, putting still more money in his purse as he did so. In 1752 he was in Mecklenburg. In 1753 he ''gathered them in'' from the highways and hedges of Denmark, Sweden, and Russia. In 1755 he almost lost his life to other bandits in sunny Italy. Two years later he was arousing keen enthusiasm among the fogs of Belgium. Then to the Orient, especially to Persia, where eyes and wallets were both flung open as if by the magic of an enchanter's hoodwinkum. And so on. In 1772 his restless feet, tongue and fingers at last were stilled in death.

John Taylor, however, was not a quack merely. He was really a dextrous operator who ''thought it sin that dupes should go to waste.'' *Populus vult decipi.*

His more important writings are as follows: 1. *History of the Travels and Adventures of Chevalier John Taylor, Ophthalmiator Pontifical, Imperial, and Royal, etc.* Written by Himself. (3 vols., London, 1763.) 2. *An Account of the Mechanism of the Globe of the Eye.* (London, 1730; Norwich, 1747; Ger. trans., Berlin, 1731; French trans., Paris, 1738, 2d ed., 1760.) 3. *Treatise on the Immediate Organ of Vision.* (London, 1735; French trans., Paris, 1735; Dutch trans., Amsterdam, 1735.) 4. *New Treatise on Diseases of the Eye or of the Cataract or Glaucoma.* (London and Edinburgh, 1736, and numerous later editions.) 5. *Impartial Inquiries into the Seat of the Immediate Organ of Sight.* (London, 1743.) 6. *Morbi Oculorum Systematice Collecti.* (Rome, 1754.) 7. *An Exact Account of 243 Different Diseases to which the Eye and its Covering are Exposed.* (Edinburgh, 1759.)—(T. H. S.)

Taylor, Oscar N. A well-known California ophthalmologist. His medical degree was received at the University of California in 1899, and he practised in San Francisco. He died at Lane Hospital, in that city, of meningitis which resulted from an intranasal operation which he performed upon himself.—(T. H. S.)

Taylor, Robert. A well-known London ophthalmologist, who introduced glycerin for xerophthalmia. Born in Dumfriesshire, Scotland,

in 1815, he received his medical degree at Edinburgh in 1841. The following year he became a Member, and six years thereafter, a Fellow, of the Royal College of Surgeons. In 1852 he was made a Fellow of the London Medico-Chirurgical Society. For 23 years (1850-1873) he was surgeon at the Central London Ophthalmic Hospital. He wrote on Sympathetic Ophthalmia (*Medical Times*), The Ophthalmoscope (*Med. Circular,* 1858) and on Cataract (*Trans. Path. Soc.*, and *Med. Times and Gazette,* 1857). Taylor died Jan. 25, 1883.—(T. H. S.)

Taylor, Robert Hibbert. A celebrated ophthalmologist of Liverpool, England, the first to lecture on ophthalmic surgery in the Liverpool School of Medicine. Born in Dumfries, Scotland, in June, 1818, he received the degree of M. D. at the University of Edinburgh in 1834, being then only 17 years of age. He then proceeded to study the eye at Guy's Hospital, London, later in Paris and Berlin.

Returning to England in 1839, he settled at Liverpool as ophthalmologist. In the very same year he founded an eye dispensary in Marylebone, which was later removed to Great George Street. In 1853 he was made an honorary surgeon to the Bristol Eye and Ear Infirmary. Sixteen years later, because of a regulation of the Institution, he was retired, but was made consulting surgeon. He wrote a considerable number of ophthalmic articles, as well as the chapters on "Diseases of the Eye" in Tweedie's *System of Medicine.* In 1886 he retired from practice, continuing, however, his interest in medical, especially ophthalmic, charities of various kinds. He died Jan. 5, 1898, aged 86, leaving a widow, five sons, and four daughters.—(T. H. S.)

Tay-Sachs disease. Amaurotic family idiocy. Agenesis corticalis. Infantile cerebral degeneration or arrested development (Sachs). Tay's infantile retinitis. Amaurotic family dementia (Coriat). This subject has been discussed with an approach to completeness on p. 287, Vol. I; as well as on pp. 5155 and 5866, Vol. VIII of this *Encyclopedia.* To the matter there provided may be added the following observations.

Tay's original case (1881) was of an infant 1 year old, who had been noticed at the age of 2 to 3 weeks to have very little power in holding up its head or of moving the extremities. This was a weakness, not an absolute paralysis. The child seemed cerebrally deficient. With the ophthalmoscope, Tay found the optic disks apparently healthy, but in the region of the yellow spot in each eye "there was a conspicuous, tolerably-defined, large white patch, more or less circular in outline, and showing at its center a brownish-red, fairly circular

spot, contrasting strongly with the whitish patch surrounding it." Some months later, Tay found no change in the child's condition except that the disks were becoming atrophic.

Sachs (*N. Y. Med. Journ.*, May 30, 1896; *Journ. Mental and Nervous Diseases,* Vol. 30, No. 1, 1903) of New York, delivering the presidential address before the New York Neurological Society in 1896, described a family form of idiocy, associated with blindness, which he designated as amaurotic family idiocy. In this communication, he referred to an earlier paper, read in 1887 before the American Neurological Association, in which he described a similar case under the title "Arrested Cerebral Development with Special Reference to its Cortical Pathology." He concludes that Tay's case and his own are similar in type and collects altogether nineteen cases presenting the same symptom-group.

The chief symptoms as originally described by Sachs are mental impairment, a more or less general paresis or paralysis which may be either spastic or flaccid, with corresponding changes in the reflexes; a diminution or loss of vision with the characteristic eye-ground changes; marasmus; a fatal termination, usually by the end of the second year, and the occurrence of the affection in several members of the same family. Occasional symptoms were nystagmus, strabismus and hyperacuity of hearing. In a later paper, Sachs accepts two additional symptoms mentioned by Falkenheim: explosive laughter and disturbance of deglutition.

Edward F. Leonard (*Illinois Med. Journ.*, p. 327, May, 1917) reports two typical cases of Tay-Sachs disease and furnishes an account of some of the theories that to the date of his paper have been advanced to explain the *etiology of the affection.* These are (1) Cortical cerebral arrest of development (agenesis) of Sachs. (2) Primary cortical degeneration (Russell and Kingdon). (3) A toxic degeneration of the motor neurones (Hirsch, who is inclined to regard amaurotic idiocy as a form of infection originating in the intestinal canal). (4) Degeneration resulting from an inherent biochemical property of the protoplasm of the nerve cells (Holmes). (5) Coriat believes that on account of the normal characteristics up to the ages of 4 and 10 months, the disease is not really an idiocy, but is a form of dementia, as the macroscopic and microscopic changes are not those of idiocy, and he suggests the name "Amaurotic family dementia." (6) Geo. E. Price (*Journ. Am. Med. Assocn.*, p. 1545, May 16, 1914) gives a complete study to date of this disease and reports a case that furnished some evidence of the probable action of congenital syphilis in the production of the symptoms of Tay-Sachs disease.

E. Nettleship (*Ophthalm. Review,* Feb., 1908) has drawn attention to a class of cases showing *amblyopia with definite macula defects in adults,* and those cases of central retinitis of idiotic infants first described by Waren Tay (*Trans. Ophthal. Soc.,* Vol. I, p. 55, and Vol. IX, p. 158, 1881). He also alluded to cases brought forward by Batten (*Trans. Ophthal. Soc.,* Vol. XXIII, p. 386), Mayou (*Ibid.,* Vol. XXIV, p. 142), and S. Stephenson (*Ibid.,* p. 144) as being possibly of such a nature that, if they had been examined earlier in life, changes similar to those found in Tay's retinitis might have been demonstrated.

Nettleship mentioned twelve cases which had come under his own observation, and which had not been definitely proved to be related to Tay's retinitis, but in which some fine changes at the yellow spot were associated with day- and color-blindness, dating from some severe derangement of nutrition.

The points common to most of the cases were: 1. Their occurrence in patients of Jewish parentage. 2. The absence of syphilitic taint. 3. The presence of day-blindness, or dislike to bright sunlight. 4. The presence of color-blindness. 5. Some form of visual defect amounting to distinct amblyopia. 6. Fulness of fields for white. 7. Changes at the yellow spot. 8. Atrophic appearance of the optic disc. 9. Defective mental ability either in the patient, or in one or more members of the family.

In two of the cases no record of color-vision was taken, in three the recognition of colors appeared to be normal, in three no changes at the yellow spot were present, in three others the optic disc showed no signs of atrophy, while in another three the mental condition was not defective.

The changes at the macula varied from a géneral haze to well-marked areas of pigmentary degeneration with some definite white spots.

Nettleship considered that if patients with Tay's retinitis survived the infantile stage, some such appearance as was presented in these cases might possibly be found. He laid stress on the question of diet as a predisposing cause in the development of this type, and suggested that a toxic cause, either in utero or soon after birth, might excite the initial stages.

Tay's choroiditis. See **Choroiditis, Guttate,** p. 2144, Vol. III of this *Encyclopedia.*

Tay's disease. The infantile form of amaurotic idiocy. See **Tay-Sachs disease.**

Tay's retinitis. See **Tay-Sachs disease.**

Tea. A plant of the genus *Camellia,* natural order *Ternstroemiaceæ,*

of which there are two well-known varieties: (1) *Camellia theifera*, var. *assamica*, or Assam tea; and (2) *Camellia theifera*, var. *sinensis*, or China tea. The Assam variety, known as "indigenous" tea, is a tree of vigorous growth attaining a height of 30 to 40 feet, with a leaf 8 to 10 inches in length. The China variety is a comparatively stunted shrub, though hardier variety growing to a height of 12 to 15 feet, with a rounder leaf about 3½ inches in length, and the calyx covered with soft short hairs. These two varieties have resulted in a hybrid which combines the hardy character of the China with the other features of the indigenous, now largely cultivated on the hills of India and Ceylon, and known as "hybrid-Assam" or Ceylon tea. The hybrids vary much in productiveness.—(*Standard Encyclopedia.*) See **Tea-leaf conjunctivitis.** Tea has been accused, though rarely, of producing a true *toxic amblyopia* (q. v.).

Teaching methods in ophthalmology. OPHTHALMIC PEDAGOGY. This section should be read in connection with a number of contributions to this *Encyclopedia;* in particular, **Ophthalmology, Literature of**; **Ophthalmology, History of**; **Physiologic optics**; **Laboratory technic**; **Schematic eye**; **Skiascopy**; **Examination of the eye**; and similar subjects that have a near relation to the pedagogic side of ophthalmology.

MEDICAL DEGREES IN OPHTHALMOLOGY.

It is well within the present decade that any national movement was made in America to provide teachers, or to furnish adequate, special instruction leading to a degree in ophthalmology. For most of our graduate teaching we have had to rely, since the rise of ophthalmic surgery as a specialty, *mainly* upon the universities and clinics of Europe.

For the progress made in the direction of purely American instruction during the past ten years we are chiefly indebted to the labors of Edward Jackson. Under the title of Supervised and Systematic Study of Ophthalmology (*Trans. Amer. Acad. of Oph. and Otol.*, Aug. 21, 1912) he pointed out that if fitness for ophthalmic practice requires certain knowledge and certain skill, adequate opportunities for getting these through the *necessary educational training should be provided.* The proper correction of errors of refraction, the application of facts and laws of hygiene in the use of the eyes, and the best assistance when the eyes suffer from trauma, infection or unfavorable systemic influences, are of the highest importance to every person in the community. Every individual in a civilized society at times requires such services. It is reasonable

that adequate provision should be made to supply them. The average graduate in medicine and the average practitioner of medicine are not prepared to give these services. The majority of the medical profession frankly acknowledge that they "do not treat diseases of the eye." Still less do they attempt to give that advice and assistance which are even less directly in relation with their ordinary line of work.

Jackson further showed that the opticians, seeing in the fitting of glasses a large and important field in ophthalmic practice inadequately provided for, attempted to seize the opportunity for themselves. At first they claimed that the fitting of glasses had nothing to do with the practice of medicine. But their leaders already recognized that optometry has so much to do with medicine that fitting of glasses will never be successfully separated from other branches of ocular hygiene and the treatment of diseases and injuries of the eye. Their foremost leader, Mr. Prentice, who formulated the striking statement, "A lens is not a pill" wrote a few months since: "I now unreservedly state my personal conviction that the public will receive the best service from practitioners who shall have in the future collegiately qualified in both optics and medicine."

Upon the supposition that Mr. Prentice was prepared to turn over the fitting of glasses to those who had received a medical education, this statement aroused quite a storm of objections on the part of the opticians. But when he made it clear that he was desirous of advocating for optometrists whatever additional education in medicine or allied lines would increase their efficiency in their own specialty, the opticians promptly accepted his view.

The ideal toward which the leaders of the American Optical Association are working, and to which they are rapidly bringing the support of their associates, is thus expressed by the secretary of the Optical Society of the State of New York: "The future eye practitioner should be one with a three-year education, two years of optometry and one year of medicine. Then the college giving such a course should confer the title of 'Dr.' and the graduate after passing a separate State board examination (an examination as independent of any medical influences as the present dental examinations are), should be empowered and entitled to care for the eyes in their entirety."

The foregoing is the outline for one scheme of systematic, supervised instruction preparatory to ophthalmic practice,—to prepare men "to care for the eyes in their entirety." It is an important rival of the plan that Jackson presents. It was and is predicated upon his belief that the civilized states of America as well as those of Western

Europe (which have boards of public health, medical examiners, state regents and universities to pass upon the qualification of students, state examinations for dentists, druggists, veterinarians, barbers, stationary engineers, plumbers, etc.) will not very long tolerate the unsupervised practice of ophthalmology. The scheme of the opticians is at least a definite proposal to end a situation that has become impossible. It will be adopted unless something better is proposed and pushed forward by those who see its superiority.

Jackson does not mean to say that the present situation seems impossible or intolerable to those who have built up a clientèle of a few thousand patients, who afford a satisfactory income in return for competent ophthalmic service. But it is intolerable for the millions who suffer from lack of competent ophthalmic service; and who could afford to pay well for such service if they knew its true value, and where and how to obtain it. It is also intolerable for the men of ability and honest ambition who see the opportunity for highly remunerative service to the community, and find no way provided through which, by a reasonable expenditure of time and effort, they can fit themselves to perform the service in question. Let us remember that customs, laws, institutions of a democracy are established not to illustrate the theories of the few, but to meet most economically and efficiently the real needs of the great mass of the people. Jackson sums up his argument for an official supervision of the practice of ophthalmology by claiming that the whole community needs efficient ophthalmic service comparable with the medical service that it finds available, such as individuals may now obtain from particular members of the medical profession who have, each according to his individual opportunities and ideas, prepared themselves to give such service. But the mass of the community cannot today get such service because there are not enough ophthalmologists, and no adequate provision to supply enough competent ophthalmologists to give it, and no method of helping the people readily to ascertain who is presumably fairly competent to give such service. With this state of affairs there is serious complaint of overcrowding in the general medical profession [a pre-war reference, it should be remembered]. What can we do to meet this situation?

The *educational training and equipment that ought to be possessed by one who would enter ophthalmic practice* include, besides an education in general medicine: (a) Knowledge of the minute anatomy of the eye, not simply of cell structures and relations, but of small details of topographic surgical anatomy, that are not taught in the anatomic courses of our medical schools. (b) Familiarity with facts

in the physiology of vision that are not and cannot be taught to all medical students. (c) A course of laboratory work in the pathology and bacteriology of the eye, such as is not and cannot be given in the courses of bacteriology and pathology in our medical schools. (d) A knowledge of optics, that other practitioners of medicine do not require. (e) Acquaintance with methods of examination that differ radically from those employed in other branches of medical practice. (f) Skill in a series of most delicate special manipulations and operations. All these things lie outside of the usual medical course, yet they constitute the essential center of preparation for ophthalmic practice. Should they, as heretofore, be neglected while the student's attention is turned in other directions? Should they be deferred until the student has studied other things, which have for him neither educational nor practical importance?

It is said that a miner must grow up in the mines to acquire the habitual caution upon which his safety, and that of his fellow-workers, depends. It is said that it takes three generations to make a glass-blower. The highest skill in the manipulation of a musical instrument is reached only by those whose practice with it begins in childhood. Is it rational to defer the practice of the delicate operations on the eye, or even familiarity with the instruments to be used in ophthalmic operations until one approaches or reaches middle life?

"The old theory was that a man should study medicine and engage in general practice, without thinking of a specialty; and after ten years of writing prescriptions, attending obstetric cases, and reducing dislocations and cutting off limbs, he might properly take up eye work. This is still commended by many who know nothing of educational methods and principles, and almost as little of ophthalmic science and art. It is still praised by some who have followed the plan, very much as the removal of tails was recommended by the fox who had lost his own in a trap. But the time has come when specialization that has actually occurred in medical practice must be recognized in medical education; just as it is now recognized by every intelligent patient who realizes something of the significance of his symptoms and desires to take most practical and immediate measures for relief.

"Special skill in a particular department of medical practice is not a matter of individual taste, ability or experience, except as taste and opportunity determine the line of study pursued. The ophthalmologist is made by pursuing a certain line of study, with the help of certain books and teachers, and the utilization of certain clinical opportunities. That a medical man possesses superior skill in a spe-

cial branch of medicine does not mean that he is of superior mental constitution, or that he has had a unique experience. The specialist does not belong in a superior class of the profession to be called consultants. His special qualifications mean that his time and effort have been given to a particular field in medicine. And one most important factor that will determine his efficiency in his special field, and also the time and energy he can give for broader culture, will be the excellence of the facilities afforded him for the study of the special branch to which he is devoted."

Jackson does not forget the possible dangers of premature specialization, or of excessive specialization. But nothing will do more to bring about premature and excessive specialization than ignoring the needs for proper specialization in medical teaching. If we do not offer to those expecting to engage in ophthalmic practice the best practical system of training, they will try the second best, or whatever is put before them by those commercially interested in exploiting the demand of the community for ophthalmic service.

The writer's belief is that the best method of training men and women for ophthalmic practice will begin with the preliminary education now required for entrance in the better medical colleges, including sufficient mathematics and physical optics. Then must come a general medical course, which should be so remodeled as to eliminate some things that heretofore have occupied a considerable place in the curriculum. Parts of organic chemistry and materia medica that belong to the highly specialized work of the pharmacist, parts of topographic anatomy that have no general educational value, and can be utilized in practice only by a limited number of surgeons who do particular operations, and parts of obstetrics that can be of no real interest to the medical man who does not attend obstetric cases, must be cut out of the course required of these students. This will make room for the teaching of the newly discovered facts and processes of general interest; and leave in the four-year medical course a little time for elective studies, that will allow the student to develop in the direction of the life work he intends to pursue.

"On such a truly generalized and more elastic medical course should be based the systematic instruction in ophthalmology. This must include first, laboratory work in anatomy, physiology and pathology of the eye. Second, clinical work in ophthalmology, which may be taken either in a properly conducted public ophthalmic clinic, or as assistant in the private practice of an established ophthalmologist. For the best training both kinds of clinical work should be included. Of such work we must demand at least one year. It ought

to be more. But the demand for one year of properly supervised work, rigidly adhered to, is a great advance over the voluntary six weeks' plan, that has heretofore been given an almost respectable standing in the estimation of the medical profession and the public.

"There must be systematic supervised reading of the literature of ophthalmology. 'Reading medicine' formerly constituted the greater part of a systematic medical course. Reading still occupies a large part of the time of the medical student, although too often it is merely cramming for quizzes or examinations. With the enormous literature of ophthalmology, both past and current, systematic reading is still of great importance; and it is worthy of careful supervision.

"Finally the time and effort of the student can be economized by assisting him through demonstrations, quizzes or conferences; and, to a moderate extent, by lectures.

"Now this laboratory work, clinical work, reading and other methods for the study of ophthalmology should be carefully systematized and correlated by standard educational institutions. The school of ophthalmology must be a department in the university. A branch of learning so highly developed cannot be turned over entirely to the proprietary educational institution, whether that be a polyclinic or a correspondence school. A broad and liberal university spirit will endeavor to utilize both the polyclinic and the correspondence method of teaching, in opening to the student every available opportunity for self-development and improvement in his line of work. But the university must keep the supervision of the educational methods and the control of recognition of scientific attainment through proper certificates or degrees."

Jackson then refers to the first adequate preparation of ophthalmic practitioners and teachers in England and America, and outlines the plan adopted by the University of Oxford in 1910 and by the University of Colorado in 1912. We first have to take members of the medical profession already interested in ophthalmology, and self-educated in it, so far as their opportunities have permitted, to try to round out and systematize their knowledge of the subject, and then by its own course, to supplement the training already obtained elsewhere. There should be offered to the medical student a curriculum that will give, along with the general medical education, some special preparation for the study of ophthalmology, and at the end of his medical undergraduate years lay out for him a course of reading, clinical work and special demonstration, that will lead most directly towards efficiency in ophthalmic practice. After this has been pursued for a year, or more, summer courses of advanced work can be

taken. This to be followed by examinations as to fitness, which, in the University of Colorado, are clinical, written, and oral.

Preparation for teaching and graduate work in ophthalmology, Northwestern University. The story of an ophthalmic "light that failed" is of interest because it shed its feeble rays some years before the inauguration of the Colorado plan. The Editor of this *Encyclopedia* in the *Ophthalmic Record* for 1913 wrote the history of this attempt as follows: Although the University of Colorado was not the first teaching body in this country to give a postgraduate course in ophthalmology, yet we believe it to be the only one that has so far started out with considerable prospects of success. For example, the writer, in conjunction with Frank Allport and other teachers in the Medical Department of Northwestern University, made a considerable effort to meet the *growing demand for thoroughly trained ophthalmologists,* but in consequence of lack of support on the part of the faculty, the attempt was abandoned.

The Editor then drew the attention of readers of the *Record* to some aspects of this subject that in 1913 seemed significant.

"In the first place it is possible that the practice of ophthalmology, like that of dentistry, may come, in America at least, to form a distinct department of surgery. The rise of "optometry" and the popular demand for refraction work as an occupation apart from medicine are but one expression of this tendency of ophthalmic practice. To those of us who regard the science and art of ophthalmology as a small but important branch of surgery, this tendency is to be deplored; we regard it as a retrograde rather than as a progressive step. Yet we must recognize and, if possible, meet the difficulty. And how better than furnishing ample opportunities, within professional bounds, for medical men to become well-trained, competent practitioners of the art? If every medical school in the country would furnish, not only to its own graduates but to those of other schools, as good an opportunity for a special education in ophthalmology as is now afforded by the Colorado Medical Faculty, most of our "optometric" troubles would vanish and we would keep within the medical fold a specialty that seems about to stray from it."

It is not alone that the postgraduate course referred to trains one to be something more than a mere "refractionist," but it furnishes in the degree of Doctor of Ophthalmology a sign by which the public—lay and professional—may distinguish the ophthalmic sheep from the optometric goat. Briefly, the requirements (which we give for the benefit of other schools) are:

One year of postgraduate work in ophthalmology, including daily

service in the eye clinic; a sufficient course of reading; attendance on demonstrations, lectures, quizzes and conferences on the refraction of the eye and its anomalies; the pathology, diagnosis, and treatment of diseases of the eye; ocular injuries and operations. The clinical work may be done in any ophthalmic hospital or clinic having proper facilities for the study of ophthalmology, with the requisite clinical service.

Summer residence work will include six or seven hours daily for six weeks, in demonstrations, clinics, laboratory work, conferences and lectures.

The last two weeks of the residence course will contain many of the above special lectures and demonstrations of interest to those who have been engaged in ophthalmic practice.

Students who are graduates of at least one year's standing from a recognized medical school, who show evidence of the necessary study of algebra, geometry, plane trigonometry, and physical optics, and who have taken the full course, including the six weeks' residence work, will be eligible to a general examination on scientific and practical ophthalmology. Those successfully passing the examination, and presenting a creditable thesis within six months thereafter, and successfully defending the same, will be eligible for the degree of Doctor of Ophthalmology.

The foregoing program was carried out in the Medical School of Northwestern University, Chicago, with enthusiasm and success for over two years. Then a change of officials, "who knew not Joseph," and a readoption of the *laissez faire* and reactionary policy pursued by the mediocre medical school of the early eighties killed a project fraught with many bright possibilities.

It is not, of course, contended that even if medical schools throughout the country were to adopt some such course as that just summarized and even if it were to be generally patronized, there would be no "refraction specialists" or "ophthalmic-optometrists," in other words, no opticians masquerading as medical men, but we would have discharged a debt that, as the late Leartus Connor so successfully and persistently pointed out, we owe to the profession and to the public, viz.: a provision for the treatment of a very large class of cases now relegated to incompetent, or rather insufficiently informed, opticians. The purely commercial aspects of refraction will, doubtless, still be maintained by those who "examine eyes free," but the excuse for it would be gone and the practice and license of "optometry" would not be in legitimate demand and would have no legal standing. The Doctor of Ophthalmology, fashioned after

a year's work from graduates in general medicine, would be a rational and consistent product and would soon put out of court the hybrid optometrist.

It is to be hoped that teachers of ophthalmology in all American medical schools will be stimulated by the marked success of this scheme —now common to the ancient University of Oxford and the new-world University of Colorado—to carry on the teaching of advanced ophthalmology as a regular collegiate course.

Legislation of the American Medical Association. Wendell Reber (*Penn. Med. Journ.*, Jan., 1913) discusses this subject in connection with the project *to extend undergraduate teaching in ophthalmology.* He reminds us that, at the time he was speaking, the present allotment of sixty hours in ophthalmology in the senior year, fixed by the majority of American medical colleges (fifty by the Council on Medical Education of the American Medical Association), permits the student to gain fair familiarity with external eye diseases, a slight acquaintance with the ophthalmoscope, some understanding of the significance of the more important eye-ground changes, a vague idea of the refractive status of the normal and the abnormal eye, a relatively definite idea of lenses and their use in the correction of refractive errors. Attendance upon ophthalmic operations and performance of these operations on animals' eyes may be added to the foregoing list; but it is doubtful indeed whether the possessor of this much knowledge of ophthalmic science could solve anything but the simplest ophthalmic problems.

Reber points out that, as distinguished from general medical practice, ophthalmic practice with all its refinements occupies a peculiar position. It resembles laboratory work in that instruments of precision are in use every minute of the working day. The ophthalmoscope is a low-power hand microscope. Its use implies fine technic and, when after three to six months' training its easy use has been learned, another six to twelve months is necessary before the observer can properly interpret what he sees. The ophthalmometer deals with infinitely small differences in the curve of the cornea. The test lenses determine even more accurately these curvature differences. The various instruments for detecting abnormal states of the ocular muscles are all devices of great precision. The perimeter is no less precise in its findings. The tonometer, the exophthalmometer, the stereoscope, the photometer, are all laboratory devices that the ophthalmologist calls to his services. Nearly all the operations in ophthalmic surgery call for this same precision, many of them requiring the use of magnifying instruments to be worn by the sur-

geon for the proper performance of the operation. Without some knowledge of physics and physiologic optics there can be no intelligent use of this working laboratory, and when the findings have been completed they must be viewed in their relation to the patient's general condition. Only in this way can it be decided whether the ocular anomalies are primary or secondary.

"To expect the undergraduate to familiarize himself sufficiently with this ophthalmic laboratory outfit even in a fifth clinical year is asking a great deal. With the present four-year curriculum administered as it is, such a hope is baseless. The most that can be hoped for from the present undergraduate is that he shall be able to diagnose and treat external eye diseases, that he shall know the appearance of the normal eye ground and appreciate the significance of inflammatory or degenerate changes in the intraocular structures when they are properly reported to him, and that he may be able to cope with some of the simpler problems in refraction. We would add as a demurrer, however, our belief that most problems in refraction are complex ones and at times very puzzling ones indeed.

"We turn, therefore, to the second proposition; namely, to attempt by legislation to fix the conditions under which ophthalmic training shall be given. At first blush this would seem the solution of the question. But immediately we are confronted with the bewildering problem of forty-eight states, each with its own state board and standards, each supreme in its right to define the scope and limits of general and special medical practice within its own confines.

At present it would seem that the only way to compass this end would be for the National Federation of State Boards, or the House of Delegates of the American Medical Association (or its Council on Medical Education) to formulate a uniform act which could be recommended for adoption and enactment by the state legislatures. There is now in the hands of the Council on Medical Education of the American Medical Association a resolution presented to the House of Delegates at the last (1912) meeting of the American Medical Association. It reads:

Whereas, It is the sense of this body that postgraduate instruction in ophthalmology and otolaryngology is on an inadequate and unsatisfactory basis; and

Whereas, No fixed standards exist whereby the fitness of practitioners may be judged; and

Whereas, There are no restrictions which might deter men from entering on the practice of this specialty without adequate preparation: therefore, be it

Resolved, That this body respectfully requests the Council on Medical Education of the American Medical Association to supply this deficiency; namely,

By the organization of postgraduate instruction in special and other hospitals supplied with adequate facilities in the treatment of diseases of the eye, ear, nose, and throat; which instruction should cover a period of study of at least two years; that a degree be conferred on those students completing the course in a satisfactory manner; that the course of study be laid out by committees from leading special societies of the United States.

"In the present state of affairs this is a far cry. But assuming that these things are possible of accomplishment, the logic of the situation would compel equal recognition and regulation, by the state legislatures, of postgraduate instruction in general and special surgery and medicine in all its various ramifications. In short, it would be not only unwise and unfair but absolutely wrong to ask for legislation in but one department of postgraduate medical instruction. Hence, some other agency must be sought in the effort to better the present situation.

"We turn to the third proposition, to extend the term of postgraduate instruction to three months, six months or even a year; in the event of either of the longer terms, the conferring of a 'degree in ophthalmology' upon production of satisfactory evidence that the work has been done. Advocates of this proposition point to the fact that three years ago, in England, the University of Oxford established a three months' course of postgraduate study leading up to the degree of 'doctor of ophthalmology,' and that the University of Liverpool has recently followed in its footsteps.

"It is to be borne in mind, however, that in the United Kingdom tradition is so strong that whatever is done by the Universities of Oxford and Cambridge is more or less binding on all the other teaching institutions of Great Britain. Conditions in this country are different. One of our educational institutions, the University of Colorado, is now making the experiment of a one year's course in postgraduate ophthalmology leading up to the degree of 'doctor of ophthalmology.'

Reber, finally, records his belief "(1) that thoroughgoing ophthalmic instruction is today best obtained in a postgraduate institution with its attached clinic or clinics, the exception being in the case of those men who may attach themselves for a period of years to a well-organized ophthalmic clinic in their own cities; (2) that legislation in behalf of postgraduate teaching does not in the light of pres-

ent conditions seem feasible; (3) that regulation is imminent and rational and can be more easily and readily achieved by coöperation among postgraduate institutions than by any other means now at hand; (4) that the six weeks' course should be abolished; (5) that a three months' minimum and a working year maximum course would probably furnish the best working basis for agreement among our postgraduate institutions; (6) that no applicant for postgraduate teaching, who has not completed three years in general practice or its equivalent in general hospital work, should be admitted to any of the well-recognized specialty courses; (7) that certified attendance upon a recognized ophthalmic clinic for one or more years (after three years in general practice or its equivalent in general hospital work) should entitle such a clinical assistant to examination for whatever degree in ophthalmology might be agreed upon among the American postgraduate institutions; (8) that this plan would provide as many well-trained workers in ophthalmic science as the nation would have need of for some years to come."

As a basis for *teaching clinical ophthalmology* Walter B. Lancaster (*Trans. Oph. Soc., Am. Med. Assocn.*, June, 1913) advocated a complete study of physiologic optics. In his opinion the subject cannot be adequately covered in a few weeks; and that from three hundred to five hundred hours is the minimum for a course designed to cover the essentials without trying to be exhaustive. He adds that the time required will depend a good deal on how much clinical work is included in this course and how much of that work is put into other courses. "To be definite and concrete, let us apportion the time among the chapters without attempting to enumerate all the headings. For dioptrics and errors of refraction allow 150 to 250 hours. This must include: a review of physical optics; dioptrics of the eye; ophthalmometry; ophthalmoscopy; retinoscopy; hypermetropia, myopia, astigmatism, presbyopia; accommodation; mydriatics; and other allied topics. For ocular muscles and binocular vision allow 100 to 150 hours. This will include: anatomy and physiology of the ocular muscles; strabismus; insufficiencies; tests; stereoscopic vision, true and false; fusion training; projection; nystagmus; torsion, true and false. For the remaining chapters allow 100 to 150 hours. Here will be included: light sense, effects of radiation on the retina and other parts of the eye; adaptation; law of Weber or Fechner; sources of light; photometry; spectroscopy; distribution of light; lighting of houses, offices, schools, and other problems of illumination; color sense, normal and abnormal, central and peripheral; apparatus for detection of defects; visual fields for form,

color, light; apparatus, sources of error, limits of accuracy; mind-blindness, optical delusions, and other psychologic problems."

Lancaster reminds us that the University of Liverpool diploma in ophthalmic surgery (D.Ch.O.) requires a three months' course of study in the university in anatomy, physiology and pathology of the eye; not less than three terms of instruction in an ophthalmic clinic recognized by the university; one term of lectures on the diagnosis and treatment of disease of the eye, and subsequent examination.

As time advanced the propaganda for adequate supervision, State and Federal, of ophthalmic teaching increased during the following years in amount and effectiveness. Numerous papers and addresses continued to appear on the subject; among them those of Hiram Woods, Frank Allport and Duane, (*Oph. Year-Book*, p. 433, 1912) the last of whom advocated the title Ph. D. for those ophthalmologists who had completed the necessary university courses in ophthalmic subjects. E. C. Ellett (*Journ. Am. Med. Assocn.*, p. 1328, Oct. 16, 1915) dwelt on the value in ophthalmic training of interns attached to our general and special hospitals. The Editor of this *Encyclopedia* endeavored to emphasize the *vital importance of the teaching of ocular pathology,* which he would entrust in every instance to a trained specialist rather than to a general pathologist. Two separate courses should be given, one for ordinary undergraduates, and a more extensive one for graduates and also for undergraduates who have already elected a career in ophthalmology. The more elaborate course should include at least twenty-five laboratory periods of two hours each.

Frank C. Todd (*Ophthalmology*, July, 1915) furnished a complete account to the date of writing of the higher preparation in America *for teachers and practitioners* of ophthalmology and especially of the plans that were adopted by the University of Minnesota. He tells us how (in 1914) the University of Minnesota Medical School established courses for the preparation of specialists, not only in ophthalmology but in all branches of medicine. The requirements for admission to these courses in all departments were: 1st. Graduation from a high-grade medical school. 2nd. The completion after graduation of one year's internship in a general hospital, or its equivalent.

The courses then cover a period of two and three years, depending upon the specialty and the length of time the student desires to devote to his work. For instance, the work in ophthalmology may be completed in two years (after the general internship, thus three years in all after graduation). Likewise the course in oto-laryngology may be

completed in the same length of time—but should the student desire to combine ophthalmology with oto-laryngology, three years (in addition to the year of general internship) will be required. Upon the successful completion of two years of work in any specialty (always in addition to the year of general hospital internship) together with the completion and written report of an acceptable piece of research work, the student will be granted the degree, Master of Science in whatever department he has conducted his work, thus, Master of Science in Ophthalmology, Master of Science in oto-laryngology, Master of Science in surgery, etc., as the case may be. And furthermore, at the expiration of three years of successful work, he may be granted the degree of Doctor of Science (in ophthalmology, etc.).

It was thought that the degree, Master of Ophthalmology or Doctor of Ophthalmology or Surgery, etc., would lead to an endless confusion, and a great multiplicity of degrees. Thus we would have D. O., Doctor of Ophthalmology, or Doctor of Otology, or Doctor of Obstetrics, while one would hesitate to use it because it is already used by the osteopaths and the "degree(?)" D. O. may be secured by an optician after one month's course (entrance requirements nil) signifying Doctor of Optics. Similarly is the master's degree applied in the same way objectionable. On the other hand the degrees M. S. and Sc. D. are well established and dignified. For similar requirements in other sciences they are granted, and by thus avoiding the multiplication of degrees a uniformity is established for equivalent work in the various specialties—while the qualification may easily be added to signify the particular field.

Todd adds: "In respect to the time when it is best after graduation in medicine for the practitioner to begin his preparation for a specialty, I blieve that whatever specialty he undertakes, the earlier after securing his M. D. degree the aspirant bends his steps in the direction of his specialty, the better."

American Board for Ophthalmic Examinations. The steps taken and the activities in operation that ended in the formation of this important pedagogic agency are described by Wendell Reber (*American Medicine,* p. 595, Aug., 1915). Speaking of the report of the Committee on Education in Ophthalmology of the Section on Ophthalmology of the American Medical Association for 1914 it says: "Under present conditions, elective work in ophthalmology is to be considered only in the fourth or subsequent years of the medical course, and in the fourth year only for those who have done satisfactory work in all branches in their earlier years and can take elective work and still do justice to the required curriculum."

Further: "The special instruction in ophthalmology which all medical students should receive should begin in the third undergraduate year of the medical course. Before the close of that year they should gain such a general view of the subject, and such facility in methods of diagnosis, as will enable them to profit by their subsequent opportunities for clinical work. The sixty hours' total assigned to ophthalmology in the general curriculum is inadequate. More time up to 120 hours seems necessary.

"In the fourth year the required work in ophthalmology should be clinical, an extreme minimum of thirty hours, or preferably sixty hours and it should be given to small groups of students daily, or each clinic day, so that cases may be watched during their course. It may be given wholly in an out-patient department, since the diseases and procedures with which it is important for every medical student to be familiar are represented in such a clinic. This, however, should be supplemented by the use of the ophthalmoscope in hospital cases and in medical out-patient clinics.

"The foregoing training in ophthalmology should be given to every candidate for the degree of doctor of medicine."

However, by June, 1913, interest had been so much aroused that committees to deal with the situation were formed in the three National Ophthalmic Bodies, namely: The American Ophthalmological Society, the Section on Ophthalmology of the American Medical Association and the American Academy of Ophthalmology and Oto-Laryngology. The committee of the American Ophthalmological Society reported back at the meeting at Hot Springs, W. Va., in May from which we quote as follows: "The committee approves the idea that in all universities and medical schools of the first class a course shall be arranged to give graduates of standard medical schools the best assistance in preparing for ophthalmic practice with the greatest economy of time; to give those already engaged in ophthalmic practice similar assistance in making up for educational defects which were inevitable when no systematic supervised course of the kind was given; and to render accessible to those already engaged in ophthalmic practice, recent advances in ophthalmic science and art. Inasmuch as the applicant for a course of this character must have the degree of M. D., he must also have passed the entrance examination of the school from which this degree was obtained, and therefore have received the preliminary education which such passing has required. The committee suggests that it is desirable that during such preliminary education he should become familiar with algebra through quadratic equations, geometry (plane and solid), plane trigonometry, and should acquire a fair

knowledge of optics. As to postgraduate ophthalmic work for a special degree in ophthalmology, the committee agrees to recommend that two years shall be devoted to the course; that is, this period of time shall be devoted to the study of ophthalmology and subjects directly related to it, with the understanding that a reasonably liberal amount of this time shall be devoted to clinical ophthalmology in any ophthalmic hospital having proper facilities for the study of clinical ophthalmology and with the requisite clinical service. It is recommended that the course of study during these two years in general terms shall include an academic and a laboratory period, during which the following courses should be available:

1. A course on the cadaver in the anatomy of the head, and therefore including the eye and its appendages, dissection of the accessory sinuses and regional anatomy of the brain; the embryology and histology of the human eye; also comparative anatomy and histology.

2. A course in physiologic optics and the physiology of vision with opportunities for work in comparative physiologic optics.

3. A course in practical ophthalmology, which should include a full measure of time devoted to the refraction of the eye, to learning the use of instruments of precision in ophthalmic work, to work in theoretic and experimental dioptrics, to work in anomalies of muscle balance, and to diseases of the eye and to medical ophthalmoscopy.

4. A course in the surgery of the eye, which should include work in perfecting operative technic on the cadaver or and with animals' eyes, supervised by a teacher competent to instruct in this branch.

5. A course in pathology of the eye, covering practical work with the microscope and including a course in bacteriology and work in the theory of serum and vaccine therapy.

6. A course on the diagnosis and treatment of syphilis, in which special attention shall be paid to the pathological condition which it creates in the eye and the nervous system.

Although among oculists at large there was some difference of opinion in regard to the *character of the degree* which shall be granted after proper examination on the subjects already named, the opinion of a majority of the committee is that the title, if gained, should be *master in ophthalmology* and not doctor of ophthalmology, because in the opinion of a majority of the committee the title master of ophthalmology is the more dignified of the two, largely for the reason that it comes less in conflict with other titles that are now being conferred, sometimes regularly, for example, doctor of hygiene or diploma in public science, and the like, and sometimes irregularly by certain organizations in this country, which might readily be confounded

with the degree of doctor of ophthalmology, for instance, the so-called degree D. O., which stands for doctor of osteopathy.

Consequently, the report further reads:

(1) It is recommended that the candidate shall present a thesis covering original work, which shall not be accepted by the board of examiners unless it is of sufficient worth to be published.

(2) The candidate must pass a satisfactory examination in all the various courses outlined in the previous recommendation, and before he presents himself for examination he shall be able to exhibit a certificate or certificates showing that he has done a suitable amount of clinical ophthalmology in a hospital or institution, recognized by the examining board as competent to supply the necessary opportunities.

(3) The candidate shall be permitted to offer work done in subjects a list of which is the following:

a. The embryology or histology of the eye.

b. The comparative anatomy of the eye.

c. Comparative physiologic optics.

d. Original laboratory investigations of the anatomy or physiology of the human eye.

e. Original laboratory investigations on the transmissible diseases of the eye, or other pathological ocular conditions.

f. Original investigations into ocular symptoms or conditions resulting from, or related to, any disease of other organs of the body.

(4) The candidate shall, if he desires, be examined on any one of these subjects, and the time he has spent upon them and the character of the examination which he passes upon them shall be accepted by the board of examiners as evidence of his availability for the degree and counted accordingly, with the understanding that this does not in the least excuse the candidate from any necessary knowledge on the other subjects which have already been outlined, to wit: (1) The dioptrics of the normal and the abnormal eye, including practical work in the refraction of the eye and the anomalies of muscle balance; (2) abnormalities and diseases of the eye and its appendages, their etiology, pathology, diagnosis and treatment; (3) the relation of ophthalmology to general medicine; (4) clinical tests to illustrate the candidate's competency in 1, 2 and 3 of the previous recommendations; (5) an examination in ophthalmic surgery. The examination shall be written or oral, or both, and practical

(5) The candidate for the degree of master of ophthalmology, it is recommended need not necessarily take all of the courses above recommended consecutively or in one university or recognized ophthalmic hospital. For example the candidate may take part of the course in

one city and part in another, but the final half year of his two years' course must be taken consecutively in that university or school from which he is to receive his degree after passing the final examination.

Finally the committee suggests that the examining board of the university or school which grants this degree shall include a representation from the department of physiology or anatomy, the department of pathology or bacteriology, the department of medicine or surgery, and in addition one or more representatives of the department of ophthalmology. In other words it is desirable that the examining board shall not be composed exclusively of representatives from the ophthalmic department.'' The report was signed by G. E. de Schweinitz, Chairman; Myles Standish, S. D. Risley, Edward Jackson, John Weeks.

In July, 1913, the committee of the Section on Ophthalmology of the American Medical Association brought in a comprehensive report part of which is as follows: ''It is conceivable that every postgraduate school engaged in the teaching of ophthalmology might issue its own certificate of proficiency, but experience in the matter of medical diplomas shows that such certificates would be of extremely variable significance, indicating but little more than the fact that a certain amount of time had been devoted to this study under certain teachers. The granting of a degree by well-known established universities after a sufficient term of resident study, the passing of appropriate examinations and the writing and defence of a thesis will give a better assurance of attainment to the desired standard. Established universities, however, are slow to admit new lines of work, and a comparatively long time must elapse before any considerable proportion of those entering on the practice of ophthalmology will seek such academic evidence of proper preparation for their work.

''A way of recognizing proper preparation for ophthalmic practice lies more directly within the power of this and similar professional organizations. The experience of the Royal College of Surgeons of England and the Royal College of Physicians of London points the way to a practical method of certifying the proper preparation for ophthalmic practice. The conjoint examining board draws examiners from twenty-one independent schools of medicine. Its examinations lead to no degree. Many who take them already have a right to practice. The expense of the examination is large ($210 in fees, apart from the expenditure of time required). And yet a large proportion of those entering on the practice of medicine and surgery in Great Britain take this examination, although about 40 per cent. of the candidates are rejected. The certificate thus obtained is recognized

throughout the profession and by public authorities as evidence of proper preparation for professional work.

"From a careful review of the conditions existing in this country we are of the opinion that a somewhat similar examination hoard to determine fitness for ophthalmic practice in America is practicable, and offers the best means for ensuring a comparatively thorough preparation on the part of those who offer themselves to the medical profession and the public as skilled ophthalmologists.

"To bring something of this kind about, we recommend that a committee of the Section on Ophthalmology of the American Medical Association, invite the cooperation of a similar committee of the American Ophthalmological Society, and the American Academy of Ophthalmology and Oto-Laryngology, in working out a practical plan for the organization and support of a conjoint board to have charge of the examination of candidates who have prepared for ophthalmic practice. Under such a board, examinations, written, oral, laboratory and clinical, could be held at convenient times in any of our large cities. The examinations could have comparatively uniform character and significance."

In their summary the said committee recommended:

"1. That a course of postgraduate study covering at least 2 years, including systematic reading, laboratory courses and one full year of clinical ophthalmology under competent teachers, be required, before any recognition of special fitness for ophthalmic practice be granted.

2. That to examine as to the fitness for practice of candidates who have undergone such preparation, a board of examiners directly controlled by the profession be established by conjoint action of the special organization of American ophthalmologists."

Signed by the committee: Hiram Woods, Walter R. Parker, William Zentmayer, William H. Wilder, Alexander Duane, Edward Jackson, Chairman.

In October, 1913, the committee of the American Academy of Ophthalmology and Oto-Laryngology at its Boston meeting made the following report:

"The present chaotic state of postgraduate teaching of ophthalmology in the United States is now too widely admitted to need any extended discussion of the subject in this report.

The trend of sentiment indicates plainly that two years of systematic postgraduate study should be the prime requisite for any recognition of that degree of skill and fitness for ophthalmologic practice that would justify special recognition of some kind. Just what form this 'special recognition' should take will be dealt with further on.

This is not the time nor place to enter upon a detailed curriculum, but your committee feels that the following essentials must be embraced in a systematic graded course:

1. A practical anatomical course on the eye and its appendages, the accessory sinuses, and the regional anatomy of the brain.

2. The anatomy and histology of the eye on a comprehensive basis.

3. Work in physics and physiologic optics supplemented by laboratory and clinical study of the refraction and accommodation of the eye; and the principles governing the various instruments of precision used in ophthalmic practice.

4. A course in the pathology and bacteriology of the eye including the theory of serum and vaccine therapy.

5. A course in ophthalmic surgery which should cover practice on animals' eyes and the cadaver; also if possible operations on living animals.

6. A course on motor anomalies of the eyes which should be both didactic and clinical.

7. A didactic and clinical course on external diseases of the eye.

8. A didactic and clinical course on ophthalmoscopic diseases of the eyes.

9. A course on ophthalmo-neurology and perimetry.

10. A course of lectures on color theories, color vision and testing, modern illumination and hygiene of the eye.

11. Clinical work for not less than one year which should include all the departments above mentioned as well as history taking and ocular therapeutics.

To test the fitness of the candidates who have met the requirements above set forth and to properly certify them to the medical profession and the community at large, your committee would urge the formation of a federated board of ophthalmic examiners to be composed of nine members, three to be named by each of the national ophthalmic bodies, namely, the American Ophthalmological Society, the Section on Ophthalmology of the American Medical Association and the American Academy of Ophthalmology and Oto-Laryngology. This examining board should have complete charge of the examinations of candidates who have prepared for special recognition.

Your committee is unanimous in the belief that all interests will be best subserved by the granting of a certificate by the board rather than any degree. This will leave to the schools or universities doing postgraduate teaching the privilege of granting any degree that in their judgment may seem fit to meet the peculiar needs of the case. At present no degree has been mentioned that meets with anything like general acceptance.

It will be peculiarly within the functions of such an examining board to allot appropriate credits to those who have worked or studied in postgraduate schools, to those who have worked in recognized ophthalmic clinics, and to those who have studied in European institutions, also to provide the details for allotting accumulated credits until they shall have reached a total of 2 years.

Your committee is unanimous in its agreement with the committee of the American Ophthalmological Society, and that of the Section on Ophthalmology of the American Medical Association, that an examining committee of the kind described is thoroughly practicable and offers the best means for ensuring a comparatively thorough preparation on the part of those who offer themselves to the medical profession and the public as skilled ophthalmologists. The certificate of such a federated board backed by the influence of these important associations, while conferring no academic degree, would surely have great weight with the profession and the public, and would soon come to be sought by most of those desiring to enter the practice of ophthalmology.

Finally your committee would recommend that a conference be arranged with the similarly constituted committees from the American Ophthalmological Society and the Section on Ophthalmology of the American Medical Association with the express purpose of taking steps toward the formation of a Federated or National or Conjoint Examiners' Board."

Signed: Edward Jackson, Walter Lancaster, Wendell Reber, Chairman.

Inasmuch as each of the three committees had been continued and instructed to arrange a conjoint meeting, this was effected at Boston after the academy committee had received its final instructions, the following persons being present:

Dr. Edward Jackson, Dr. Hiram Woods, Dr. Walter Parker, Dr. Frank Todd, representing the American Medical Association; Dr. Myles Standish and Dr. Walter Lancaster, representing the American Ophthalmological Society, and Drs. Jackson, Lancaster and Reber, representing the American Academy of Ophthalmology and Oto-Laryngology. Dean Arnold of the Medical School of Harvard University was present by invitation.

Edward Jackson was elected president of the conjoint committee with Walter Lancaster, secretary.

After reporting back for instructions to their respective national bodies the American Board of Ophthalmic Examinations was duly constituted in the spirit of the foregoing suggestions. Since then it has continued its proper work and has issued its diplomas to a goodly

number of ophthalmologists in this country. Its activities have stimulated universities, colleges and hospitals interested in ophthalmic science to assist in preparing conditions for the diploma of the Board, and in many other respects it has furthered the progress of medicine as a whole.

An outstanding experience of the recently erected Board is, Edward Jackson (*Am. Journ. of Ophthalm.*, Dec., 1918) tells us, in the students' lack of the preparatory training which would enable them to profit by their clinical studies. The systematic courses of graduate teaching in ophthalmology, where instruction is given in ocular anatomy, pathology, and optics, are taken by only a minority of those who are preparing for ophthalmic practice. Even an internship in an ophthalmic hospital is largely thrown away on a medical graduate who is ignorant of ocular anatomy and pathology and of physiologic optics. Plane trigonometry is essential to an intelligent study of optics, but is nowhere a preliminary to the study of medicine.

In the department of clinical work the most important portions are diagnosis and the exact estimation of errors of refraction. In the examinations of the American Board even men of rather large clinical experience are found lacking in recognition of intraocular conditions and the exact estimation of refractive errors. The worst defects in the present training for ophthalmic practice would be met, if each university that has a medical department would establish short courses in physiologic optics, ocular anatomy, and ocular pathology, and would bring these to the notice of every medical student, as courses to be taken before seeking clinical training for ophthalmic practice.

The ophthalmic examinations conducted by the American Board for Ophthalmic Examinations now serve as the examinations of the ophthalmic candidates for fellowship in the American College of Surgeons.

The American School of Military Ophthalmology. The institution of this School has not only been of great value to the military establishment but its influence upon ophthalmic practice and pedagogy will continue to be felt long after the declaration of peace.

Lieut.-Colonel G. E. de Schweinitz (*Amer. Journ. of Ophthalm.*, Dec., 1918) has given an interesting account of the organization and development of the School, as a part of U. S. General Hospital No. 14. A new building of two stories had been placed at the disposal of the school. "The first floor includes refraction rooms, stalls for retinoscopy and ophthalmoscopy (in one of which a lantern screen can be readily adjusted), a room for the purposes of the optician, which also serves as a place for the clinical clerk to take the patient's history and record

the preliminary visual tests, and a covered porch which, in suitable weather, is used as a waiting room. The first floor also contains a room for operations upon animals' eyes, a small theatre for such operations upon human eyes as do not call for the administration of a general anesthetic, and rooms for the Chief of Service and the storing of records. The space still remaining is fitted as a ward of sixteen beds. The second floor of the building is occupied by beds (should such be needed), together with the usual offices connected with a sick ward. The operating theatre of the neighboring Oto-Laryngological building is used for operations upon the eye which require a general anesthetic. An entrance examination must be passed before an officer is admitted to the School of Ophthalmology. At the end of each four weeks' course the students are graded according to a report from the instructors after a written and oral examination. The Director of the School determines the degree of proficiency of each student, and it is upon this that the officer's ultimate retention for eye work in the Army is based. The staff of the School consists of a Director and Chief of Service, and eight instructors, selected on account of their records as teachers and practical ophthalmic surgeons prior to entering the Medical Corps of the American Army. Material is obtained from several sources: (1) the regular dispensary service of U. S. General Hospital, No. 14, (2) patients from the eye ward of the same hospital, (3) recruits examined elsewhere, and (4) patients in the general medical, surgical, and neurological departments of the General Hospital. At the present time between 500 and 600 patients attend the School per month. The length of the course is four weeks, and it includes the teaching of refraction, muscle and other functional testing, anatomy and histology of the eye and its appendages, external diseases, ophthalmoscopy, operations, and ophthalmic neurology. Liberal use is made of the lantern, diagrams, freehand drawings, and microscopic slides. A feature of importance is the work done in co-operation with the other departments of the General Hospital, notably those of anatomy, surgery, oto-laryngology, X-rays, pathology, and bacteriology."

Ophthalmic Teaching and Clinical Advantages in Great Britain and other Foreign Countries. The *British Journ. of Ophthalm.*, p. 165, April, 1919, gives the reports of the Council of British Ophthalmologists on the teaching and examination of medical students in ophthalmology both in Great Britain and in other countries. The report contains much valuable information, and is here abstracted as follows: After many years of agitation, on Nov. 26, 1910, the General Medical Council adopted the following report of their Education Committee:

"In the curriculum of all the licensing bodies, with three exceptions.

special courses on ophthalmology form an essential part. The committee are of opinion that every student of medicine should receive some special instruction in the subject. The committee do not think it necessary to insist that every student should be examined in ophthalmology, but they are of opinion that all students should be liable to be examined in some branch of the subject."

In 1911, a communication from the British Medical Association asking that the study of ophthalmology should be made compulsory in the medical curriculum, was brought before the General Medical Council. In reply the attention of the British Medical Association was called to the report by the Education Committee in November, 1910, just cited.

The report then considers existing regulations concerning the teaching and examination in ophthalmology in the United Kingdom and abroad, and discusses the present condition of ophthalmic training and examination in Great Britain and abroad.

A circular letter was sent to the principal universities and other examining bodies at home and among the allied and neutral countries. In consequence of the war, the circular probably failed to reach some of those to whom it was addressed.

Answers have been received from 22 examining bodies in Great Britain and Ireland and from 26 colonial and foreign universities.

A. The teaching and examination in ophthalmology in the United Kingdom.

(1) The requirements as to training are as follows:

a. No certificate of training in ophthalmology required: Universities of Oxford and Cambridge.

b. Ophthalmology one of four optional special subjects, certificates required for two only: The Society of Apothecaries of London.

c. A certificate of attendance at an ophthalmic clinic for three months required: Universities of London, Liverpool, Aberdeen, Dublin (Trinity College), Queen's University of Belfast, Conjoints R. C. S. England and R. C. P. London, R. C. P. and S. Edinburgh and R. F. P. and S. Glasgow (13 attendances), R. C. P. and S. Ireland.

d. Certificates of attendance on a course of lectures and clinical instruction required: Universities of Edinburgh, Glasgow, St. Andrews, Wales, Durham, Birmingham, Manchester, Sheffield, Bristol, Leeds, National University of Ireland.

(2) The methods of examination are as follows:

a. An occasional question in the surgery paper, or viva voce; the examiners not being ophthalmic surgeons: Universities of Oxford, Cambridge, London, Durham, Leeds, Sheffield, Bristol, Glasgow, Aber-

deen, Wales, Conjoint Exam. Boards R. C. S. England and R. C. P. London, R. C. P. and S. Edinburgh and R. F. P. S. Glasgow, Society of Apothecaries of London.

b. Special examination conducted by ophthalmic surgeons as part of the qualifying examination: University of Dublin (Trinity College), National University of Ireland, Queen's University of Belfast. Royal Coll. of Phys. and Surg. Ireland, Universities of Liverpool, Birmingham, Manchester.

c. Class examinations. The certificates required before admission to the qualifying examination given only to students who attend a recognized course regularly and reach a defined standard in the class examinations: Universities of Edinburgh and St. Andrews (commencing 1919).

(The regulations under (a) also apply to these two Universities.)

B. The teaching and examination in ophthalmology in Colonial and Foreign Universities.

America. United States: University of Michigan, Ann Arbor, Mich.: Johns Hopkins University, Baltimore, Md.: Harvard University, Boston, Mass.; Northwestern University, Chicago, Ill.; University of Illinois, Chicago, Ill.; Rush Medical College, University of Chicago, Chicago, Ill.; Western Reserve University, Cleveland, O.; University of Kentucky, Louisville, Ky.; University of Bellevue Medical College, New York; University of Columbia, New York; University of Cornell, New York; Yale University, New Haven, Ct.

Canada: McGill University, Montreal; University of Toronto.

All the above, with the exception of Northwestern University, Chicago, require students to attend both a course of lectures and a course of clinical instruction, and hold special examinations conducted by ophthalmic surgeons. Northwestern University, Chicago, requires a certificate of attendance on a course of clinical instruction in ophthalmology and there is no special examination.

France: University of Paris. Clinical course in fourth year. Certificate after examination. University of Toulouse: Clinical course of one term. Ophthalmology alternates with dermatology as a special subject in the qualifying examination. University of Lyons: Clinical course of one term. University of Montpellier: No certificates required.

Switzerland: The State examination for a diploma to practise medicine includes an oral and practical examination in ophthalmology conducted by two ophthalmic surgeons. University of Basle: A course of lectures during two terms and a clinical course of three terms. University of Lausanne: Clinical course of one term.

Spain: Central University of Madrid: Course of 82 lectures and clinical attendance from October to May. Examination at the end of the course conducted by the Professor of Ophthalmology. University of Barcelona: Course of 68 lectures; otherwise exactly as Madrid.

Sweden: The examination in ophthalmology is entirely practical and oral, and is conducted by the Professor. University of Upsala: A course of lectures and two months clinical course.

Norway: Viva-voce examination as in Sweden. University of Christiania: Clinical course of one term.

Denmark: University of Copenhagen: Clinical course twice weekly during one term. Occasional question in the surgery paper in the qualifying examination.

Japan: University of Kyoto: A course of lectures and a clinical course. The examination in ophthalmology is oral and is conducted by ophthalmic surgeons.

THE METHODS AND MACHINERY OF OPHTHALMIC PEDAGOGY.

As stated in the opening sentences of this section many of these appliances have already been discussed and pictured elsewhere in these pages. A few additional examples are now listed, mostly under the inventor's name and in alphabetical order.

In this connection *Oatman's stereograms* and the *Atlases* mentioned under **Ophthalmology, Literature of** should not be forgotten; nor should the *papier maché* and wax models, maps, etc., to be had from most dealers. Every teacher should be a good draughtsman and be able himself to make diagrams and to wield colored crayons for blackboard illustration. The *stereopticon, epidiascope, photomiscroscope* and all other forms of projection apparatus are also indispensable to effective teaching.

Burnett's models demonstrative of cylindrical refraction. These show how light is refracted by two superposed cylindrical lenses. They originated with the late Dr. Swan M. Burnett, who, in 1888, entrusted their design and construction to the writer. In order to accomplish this with the necessary precision, it became necessary mathematically to determine the refraction of two cylindrical lenses whose axes crossed each other at an acute angle. The models were executed in gilded metal and ensued from the investigations which simultaneously led to the publication of a 48-page monograph: *Dioptric Formula for Combined Cylindrical Lenses*, by Charles F. Prentice. See **Ophthalmic lenses and prisms**. The models were used by the late Dr. Burnett, Prof. of Ophthalmology

at the University of Georgetown, Washington, D. C.—(C. F. P.) See the illustration under *Prentice's class model*, in this section.

Demonstration ophthalmoscopes. See p. 3814, Vol. V of this *Encyclopedia.*

Head's fundus charts, by Arthur Head, F. Z. S., are finely executed in colors true to life and are considered very accurate representations of the numerous types they depict. Head has published a small *Atlas of the Fundus* specially intended for medical students. See the (sample) figures.

Knapp's thread model represents rays of light and demonstrates the effects of astigmatism. See the figure.

Knapp's ophthalmotrope is an apparatus for demonstrating the

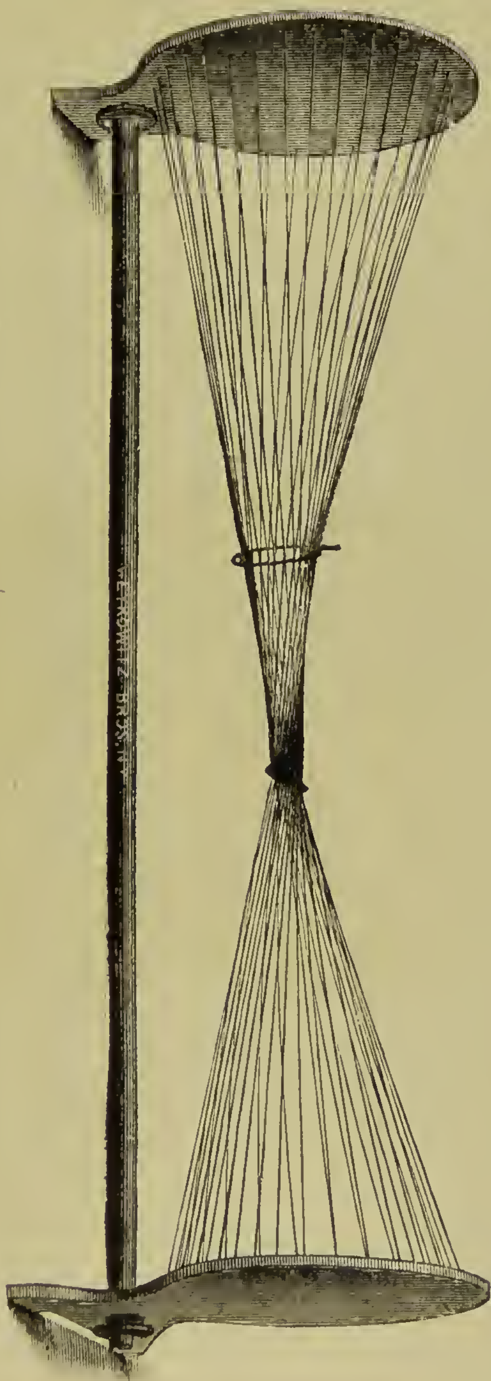
Head's Fundus Charts.

movements of the eye and action of the different muscles which produce them. See the illustration on p. 6860, Vol. IX of this *Encyclopedia.*

Kühne's optical box is again mentioned on account of its value for teaching dioptrics. See p. 6881, Vol. IX of this *Encyclopedia.*

Landolt's ophthalmotrope is used to demonstrate the rotation of the eye-ball by the various extrinsic muscles. Different colored rods indicate the central axis of rotation when clamped between the respective adjustment screws, as indicated in the cut. It may be employed to represent either eye.

Meyrowitz retinoscopic eye. This little device is made of brass with concave eye ground and properly colored retina, adjustable for skiascopic demonstration of myopia and hypermetropia. Posts are provided for supporting cylindrical lenses before the eye. The axis scale



Knapp's Thread Model.

This device represents rays of light and demonstrates the effects of astigmatism.

is on white celluloid, easily seen in the dark room. Consult the figure.

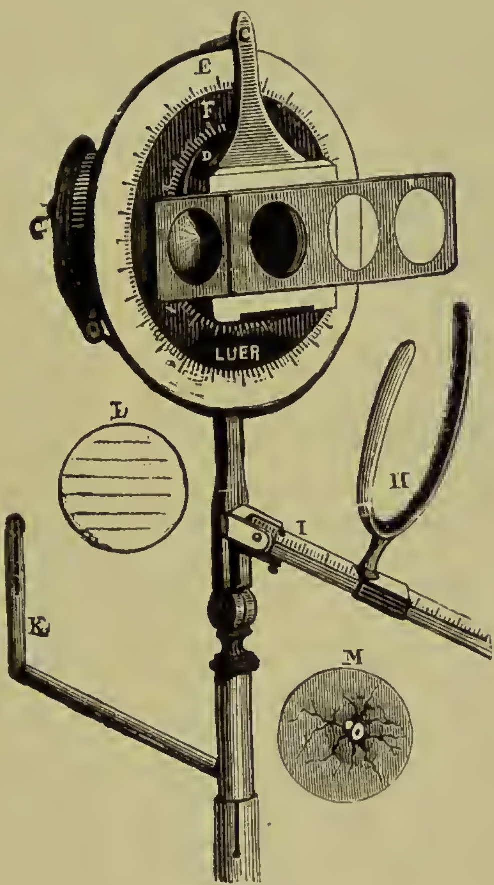
Monthus' stereoscopic photographs. A. Monthus (*Iconographie Stereoscopique Oculaire;* Part 1, Masson & Co., Paris, 1908) conceived the idea of *illustrating various pathological conditions of the eye and certain operative procedures* by means of stereoscopic photographs. The first part consists of twenty-five plates, each plate being of course double and being adapted for use with the stereoscope. The subjects illustrated are the *orbit* both in a physiological condition and when attacked by tumor, epibulbar new growth, tarsorraphia, probing of the nasal duct, excision of the sac, etc. In the accompanying text Monthus has been careful to keep strictly to a description of the plate and what it shows.

Meyrowitz Retinoscopic Eye.

Parent's eye swings on a movable axis, with a needle for indicating the degree of ametropia. It is provided with a series of lenses, especially for demonstrating astigmatism, and a number of colored charts representing fundus changes for teaching students the use of the ophthalmoscope. See the illustration.

Prentice's astigmatic eye model is made to represent the anterior half of the eyeball, and consists of a hollow, pliable rubber hemisphere within which are fixed two narrow steel bands, placed at right angles to each other and extending from the pole to the equator of the hemisphere. These spring-acting bands serve to instantly reestablish the normal sphericity of the hemisphere upon release of any compression of its opposite sides that may have been brought to bear between the fingers of the operator in demonstrating ocular astigmatism. Four steel wire rods are permanently affixed to the equatorial extremities of the steel bands, and project into space so as to there converge to a

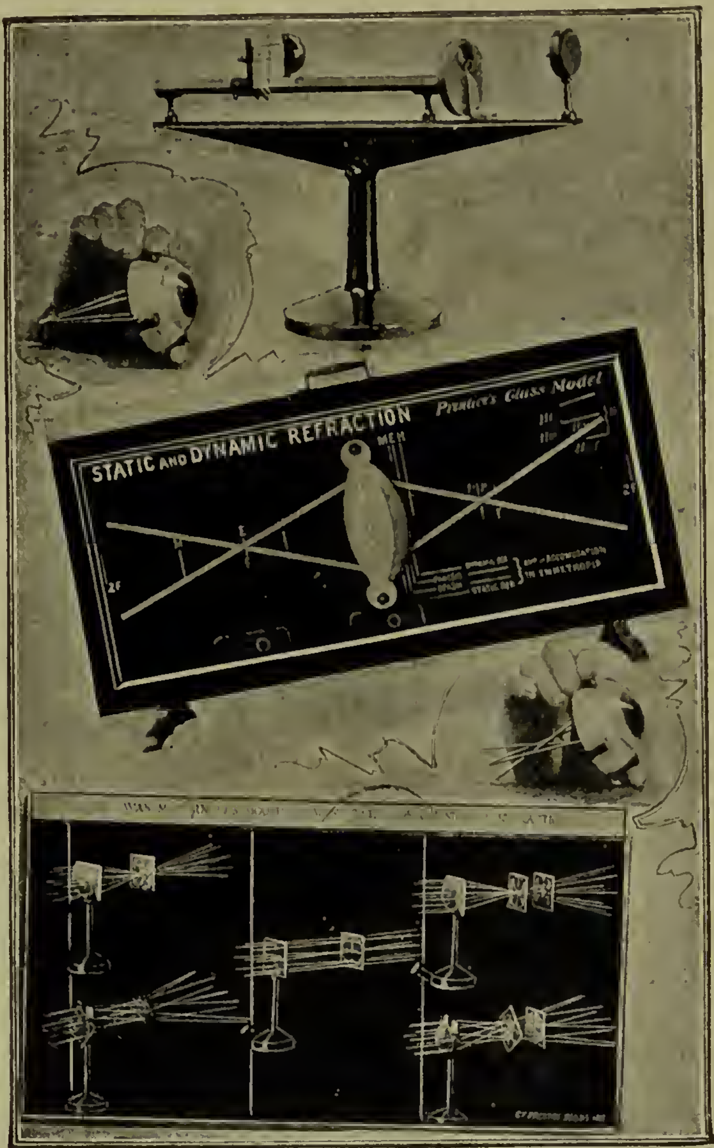
point, which is supposed to be their common focus, when the hemisphere is in its normal spheric form. Two of the diametrically opposed wires are soldered together at this point, so that compression of the hemisphere, externally to the points of insertion of the other pair of wires, causes this pair of wires to converge to a point nearer than the common focus, thus exhibiting a focal interval between the points where each pair of wires cross each other.—(C. F. P.)



Parent's Eye.

Prentice's class model. This is an instrument for demonstrating mechanically the refraction of a biconvex lens, as well as the refraction of the lens in the human eye, in order to show its power and amplitude of accommodation (see fig.). When employed to exhibit the refraction of a lens, the incident and the refracted rays, consisting of four aluminum bars, are caused pairwise to change their relative positions, corresponding to those of their associated conjugate foci, by means of a milled head, which is guided by the operator's hand along a slot near the left-hand lower edge of the blackboard, and upon whose face the visible operative parts of the apparatus are mounted. When used to illustrate lenticular accommodation, the milled head is tightly

clamped so as to cause the refracted rays, on the left, to cross each other fixedly at any one of the points, E, H, or M, designating the location of the retina of the emmetropic, hyperopic and myopic eye, respectively. The incident rays, on the right, will then have correspondingly assumed the directions of parallelism, convergence or



Prentice's Class Model.

divergence with respect to the elevated lens-section in the center of the blackboard. In order to place the incident rays in position to assume divergence from any point at *finite* distance, the thumb-button, just below the lens-section, is pushed to the right, thus causing the lens-section to become more and more convex at its anterior surface until the punctum proximum, pp, is reached. For instance, in emmetropia, the pole of the accommodated lens will thus have reached the

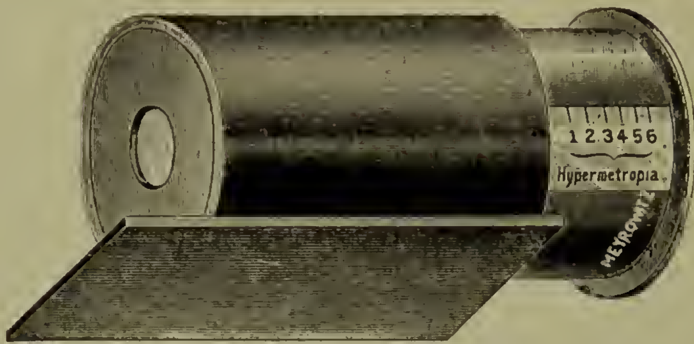
perpendicular line at whose foot a corresponding horizontal line indicates the maximum accommodation required to see an object at the punctum proximum. Hence, the amplitude of accommodation is shown to be embraced between the horizontal lines which correspond to the perpendicular lines that are tangential to the surfaces of the static and dynamic lens-sections. Intermediate adjustments of the thumb-button make it possible to illustrate also spasm and paresis of accommodation in emmetropia. In case the instrument is adjusted for hyperopia, the incident rays for which such an eye is statically adapted become convergent, so that the upper one of these rays assumes the position corresponding to the upper convergent line above Ht, which indicates the total hyperopia. Propulsion of the thumb-button, to the right, causes the lens-section to swell in accommodation, and the incident rays simultaneously to assume a lesser convergence while passing through the range of the lines Hl, Hm and Hf, which correspond to latent, manifest and facultative hyperopia, respectively. Hence, it is demonstrable that a quota of accommodation is exercised between the limitations of total and facultation hyperopia, which is in excess of the requirement in emmetropia; wherefore, the thumb-button must be still further advanced in order that the same punctum proximum may be reached. The total accommodation then in force is indicated by the perpendicular line, H, which is the tangent to the lens-section at its maximum curvature. The model may also be adjusted similarly to show that less accommodation at the same near point is required in myopia than in emmetropia or hyperopia. This unique instrument was designed by the writer in 1884, and, so far as known, is the only one of its kind in existence, having only recently been put to its intended purpose of class instruction in the Department of Physics, at Columbia University, New York.—(C. F. P.)

Prentice's prismometer was originally intended to measure the dioptral power of prisms at finite distance. However, as the writer subsequently discovered the application of this principle to be incorrect, he later suggested that prisms should be measured at 6 meters distance from the prismometric scale (q. v.), in order to secure parallelism instead of divergence of the incident rays.

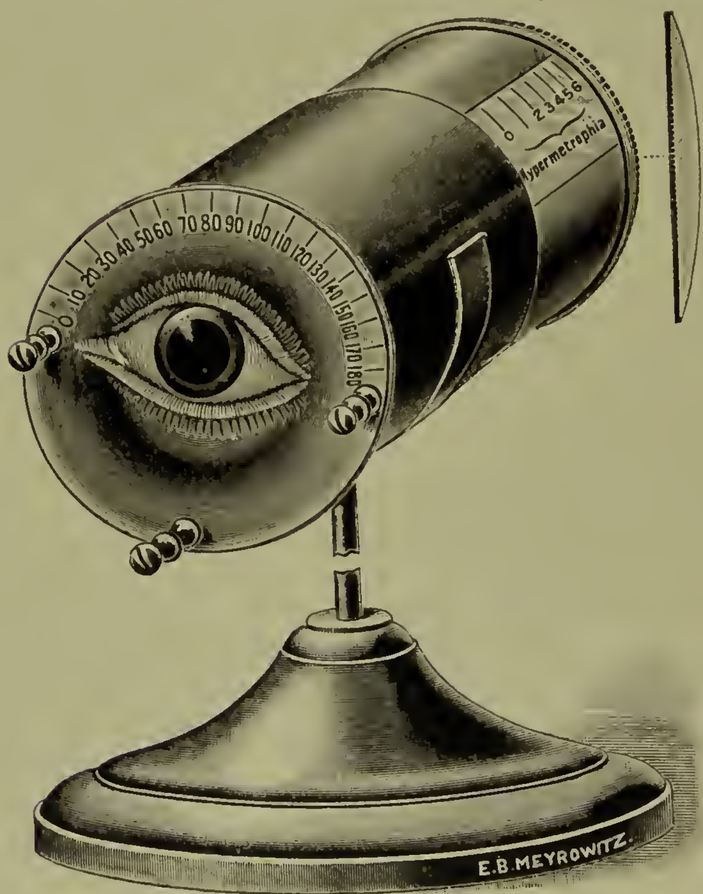
Schematic Eyes. See **Ryland's schematic eye**, as well as under **Schematic eye.**

Skiascopy eye. This is one of numerous models. It is a simple device, telescopic, with a scale showing the degree of hypermetropia and myopia produced. It is also provided with the picture of a normal fundus. See the cut.

Thorington's retinoscopic eye is made of brass and mounted on a stand. It is adjustable for producing any degree of myopia or hypermetropia, as well as cells for holding cylinder lenses to produce astigmatism. See the figure.



Practice Eye for Retinoscopy.



Thorington's Retinoscopic Eye.

Ophthalmic post-graduate schools. These, mostly proprietary, institutions (whose value for pedagogy varies greatly) are found in all our large cities, but, unfortunately, instruction in them is largely fragmentary, and often defective, does not follow any prescribed

course, is subject to little effective supervision and does not lead to any degree or diploma with a recognized value. These defects are, however, much less noticeable than formerly, and will probably be remedied in the future—if they are to take any large part in the teaching of ophthalmology.

Tea-leaf conjunctivitis. See **Tea.**

Teale's operation. For symblepharon. See p. 1101, Vol. II of this *Encycolpedia.*

Teale, Thomas Pridgin. A celebrated English surgeon and ophthalmologist, son of a general physician, Thomas Teale, and father of the still more famous Thomas Pridgin Teale, Jr. Born at Leeds in 1801, he studied at Guy's and St. Thomas's Hospitals, London, and became M. R. C. S. in 1823. Settling in Leeds, he became in 1824 surgeon to the Leeds Public Dispensary, a position which he held for about nine years. He was one of the founders of the Leeds Medical School, and for more than 25 years was very active in this institution, teaching anatomy, physiology, and ophthalmology. He was made an F. R. C. S. in 1843. He had an especial reputation as a lithotomist and herniotomist, but was also widely known as an operator on the eye. His only ophthalmic writing was entitled "On Stricture of the Lachrymal Duct" (*Ed. Jour. of Med. Sc.*, 1828). He died Jan. 2, 1868, aged 67.—(T. H. S.)

Tears usually consist of pure water, with saline traces, but in cases of systemic poisoning may show the poison, and in diabetes become saccharine like the other secretions. Serving normally to moisten the eyeballs (especially the conjunctivæ), and nose, they are regularly secreted in normal quantities, and disappear by way of the naso-lachrymal duct into the nose. See, also, p. 6928, Vol. IX of this *Encyclopedia.*

Tear sac. See **Lachrymal apparatus.**

Tears, Bloody. In addition to the matter on p. 1233, Vol. II of this *Encyclopedia* the notes by M. J. Konikow (*Boston Med. and Surg. Journ.*, Oct. 26, 1916; review in the *Lancet*, Dec., 1916) on this curiosity of medical literature are interesting. The writer reports the case of a man, aged 50, who had been in good health except for attacks of slight epistaxis. An attack occurred which he and the members of his family could not control by ordinary means and Konikow was summoned. Blood was flowing freely from the right nostril. An anterior tamponade failed to stop it, merely directing the flow backwards. Complete stoppage was obtained only by anterior and posterior tamponades. A few minutes later large "bloody tears" began to run down the cheek from the right eye. Pressure on the right nasal duct stopped this flow. Of course the source of these

"tears" was the blood that was caught between the tamponades and forced into the nasal duct. True sanguineous lachrymation, i. e., "bloody tears" produced directly by the lachrymal gland—must be extremely rare, if indeed it has ever occurred.

F. R. Cross (*Trans. Ophth. Soc. U. K.*, 1890-91) reported the case of a female, aged 21 years, who for several years had been suffering from bloody tears, coming occasionally from the left eye. Excluding other sources, Cross thought that the lachrymal gland was responsible for this phenomenon. Half a century ago, Hasner reported two cases of bloody tears, one in a girl of 13, who showed this symptom during the two years preceding her first menstruation; the other in a healthy young butcher in which the cause of the trouble lay in a lentil-sized polypus of the upper conjunctiva.

S. W. Ochapowski reported a case of "bloody tears," which he attributed to the general character of the patient—a sufficiently puzzling diagnosis.

Tears, Blue. An example of what must be among the rarest of ophthalmic phenomena is reported by Weidler (*Oph. Year-Book*, p. 279, 1916) in a patient, aged 17, afflicted with hysteric amblyopia, who complained of headaches and trouble in seeing. The vision in each eye was 20/50, improved with glasses. When presented it was 20/200 in each eye. The visual fields were concentrically contracted, but the patient had no trouble in orientation. There was marked reduction of accommodation, photophobia and lachrymation constantly present. Marked angio-neurotic edema, which almost closed the eye-lids, was seen. For the preceding six weeks, the patient had been secreting a bluish-green fluid from the conjunctival sac, which gave the appearance of blue tears. These were examined chemically and bacteriologically with negative results. The patient showed other stigmata of hysteria.

Tear stone. See **Leptothrix lachrymalis,** p. 1373, Vol. II of this *Encyclopedia*.

Tebaldi, Augusto. A well known Italian psychiatrist, author of two or three articles of ophthalmologic interest, the chief of which is "Oftalmoscopio nella Alienazione Mentale" (*Riv. Clin. di Bol.*, 1870). Born Jan. 31, 1833, at Verona, he received his medical degree at Padua in 1859, settled in his native city, there became professor of psychiatry in 1874, and died Sept. 15, 1895.—(T. H. S.)

Technic, Laboratory. See **Laboratory technic,** p. 6886, Vol. IX of this *Encyclopedia*.

Tecoma ipé. A Brazilian plant having astringent properties. The bark is used as a wash and the leaves in ophthalmia.

Teeth, Ocular relations of the. The discussion of this important subject has already been carried to the date of publication on p. 3817, Vol. V; and on p. 6603, and p. 6660, Vol. IX of this *Encyclopedia*. See, also, **Riggs' disease**; and in particular **Pyorrhea alveolaris**, p. 10809, Vol. XIV. To the matter there considered a few, mostly later, observations are added in this section.

A well-marked case of *homonymous crescentic scotomas in association with ethmoiditis and tooth-root abscess* is reported by G. E. de Schweinitz (*Ophthal. Rec.*, April, 1915). A man, aged 45, of good health and habits, suffered one month previously from pain over the left eye. Following this there was slight blurring of vision. Examination of the field of vision showed homonymous paracentral scotomata and there was some loss of vision in the left eye. The x-ray showed several abscesses of the tooth roots and a posterior ethmoiditis. Appropriate treatment, especially of the teeth was followed by improvement. de Schweinitz is not prepared to locate with exactness the lesion responsible for these scotomata, but regards it as not impossible that they were situated in the left optic tract. They may possibly have represented incomplete ring scotomata. The fundus examination was negative.

Reflex ocular disturbances due to impacted third molars. A clinical report on this subject is that of Howard V. Dutrow (*Ophthal. Rec.*, May, 1916). A man, aged 22, gave a history of having had several attacks of severe headache, followed by vomiting, which relieved his headache temporarily. At this time he had a complete paralysis of the left external rectus muscle. The right eye was elevated and rotated inward, due to the spasmodic contraction of the superior rectus and the superior oblique. The fundi were normal. After the extraction of impacted molars the patient improved generally and within a month muscle balance was entirely normal; the gastric symptoms and the headaches entirely disappeared.

Additional proof of the *causative relation between dental diseases and eye symptoms* is furnished by A. E. Ibershoff (*Jour. Ophthal. and Oto-Laryng.*, July, 1915), who reports two recent cases (three previously) of ciliary disease due directly to decayed teeth, which was promptly relieved by appropriate and thorough dental work. Each of these patients presented the classical symptoms of web-like vitreous opacities, plastic deposits on Descemet's membrane, diffuse cloudiness with obstruction of the fundus and great loss of vision.

W. H. Haskin (*Dental Cosmos*, Sept., 1916) furnishes a practical paper on *diseases of the eye as the result of focal infections of the teeth* in which he says that transillumination of the alveolar proc-

ess with light of varying intensity will often disclose areas which, in the writer's opinion, invariably indicate trouble. The writer has never seen a gold cap crown, either when single or when used on two or more teeth to serve as anchors for fixed bridges, that was not the cause of sepsis sooner or later, and feels that they should never be allowed in any mouth. Reflex pains are very frequent, and may affect any part of the head, the ears being particularly liable to this form of attack. Fixed bridges are all liable to cause trouble and become lodging-places for sepsis very shortly after being placed, as it is impossible to clean all around them. Specimens of bones, wet sections, and ground teeth will demonstrate without words just what does take place in these conditions, and how impossible it is to eradicate such areas of infection through the minute apices of the root-canals. The writer has studied radiographic pictures of several hundreds of extracted teeth, and has proved how impossible it is to hope to have filled the root-canals in a large majority of them. Multiple foramina at the apices, angular terminations, excessive curving and double curving, two canals uniting and then terminating in multiple foramina, and other peculiarities that presented mechanical obstructions to root-canal filling, were found in great numbers. It is a fact that many of these conditions cannot be demonstrated in the teeth when in situ, owing to the shadows of the jaw-bones themselves. It is hard to have to insist upon removal of teeth in many cases, and no tooth should be needlessly sacrificed under any circumstances: but one should never be satisfied that the foci have not been the cause of other diseases until every possible area has been investigated, either by extraction of the tooth or by an opening through the alveolar process to expose the apex of any suspected area.

W. F. Steinbugler, Levy and Pease (*Archives of Ophthalm.*, p. 182, Vol. 47, 1918; abst. *Am. Journ. of Ophthalm.*, p. 83, May, 1919) report *two years of oculo-dental work* at Herman Knapp Memorial Eye Hospital. Fifty-three cases were examined, the diagnosis of these being as follows: Acute iritis and iridocyclitis, 13; acute and chronic choroiditis, 10; chronic iridocyclitis, 9; postoperative iritis, 4; detachment of retina, 4; episcleritis, 2; dendritic keratitis, 2; and one case each of chorioretinitis, chronic cyclitis, iridochoroiditis, interstitial keratitis (nonspecific), vesicular keratitis, keratoiritis, retrobulbar neuritis, retinal hemorrhage, and ulcer of the cornea.

In examining this series of cases, fifty-two of the fifty-three patients showed dental infection on the same side as the affected eye. This would lead to the belief that infection does not occur through the blood stream, as, if this were so, it would seem that more cases

in which dental infection was present on the opposite side to the affected eye would have been noted. In view of this observation it is a logical conclusion that infection is carried either by means of the lymphatics or through osseous channels.

The following conclusions were reached: (1) Dental infection does not present a definite clinical entity although it is most often seen in the form of a low-grade chronic infection involving the iris, choroid, and ciliary body. (2) Dental infection is more frequent than has heretofore been believed, and it must be carefully sought for by means of the x-ray. (3) The infection is carried to the eye, in all probability, through the lymphatics and osseous channels. (4) The *streptococcus viridans* is the organism most frequently found in cultures from tooth roots or sockets, and is the main bacteriologic factor. Other organisms, as the staphylococcus, pneumococcus, and bacillus pyocyaneus, must also be considered. (5) In acute cases a mixed infection is the rule, the streptococcus viridans being most often associated with the staphylococcus; whereas in chronic cases the viridans alone is common. (6) The streptococcus complement fixation test has not given satisfactory results, the findings not being consistent with the clinical picture.

Hunter H. McGuire (*Trans. Am. Oph. Soc., p.* 362, 1918) lists twenty-five *ophthalmic cases in which dental sepsis appears to have been the exclusive cause,* and comments upon the fact that the uveal tract was involved in no fewer than 18 of them, which is in accordance with the findings in the longer series of 57 cases by Levy, Steinbugler, and Pease (*supra*), and is not at variance with the experiences of other observers. That general oral sepsis or extensive pyorrhea alveolaris need not necessarily be the cause of uveitis, which, on the contrary, may be due to a small root abscess not discoverable until x-rays are employed, is borne out by the author, who found that blind dental abscesses were the etiological factor in fully 75 per cent. of his cases. Another fact brought out by McGuire's series of cases was that even in the presence of extensive pyorrhea, which had existed for long without causing any eye trouble, the sudden development of an apical abscess has often proved to be the exciting cause of an ocular lesion. In several of the author's cases crowned teeth were the cause of eye mischief. This causes him to enter a plea for not limiting a dental x-ray examination to suspected teeth alone. He reports a case in which paralysis of the ciliary muscle (uniocular) was caused by a peridental abscess, and another of panophthalmitis set up by a number of septic roots, and a third of optic neuritis the result of dental abscesses and pyorrhea.

McGuire concludes that ocular lesions dependent on dental sepsis are not rare, and other factors having been eliminated, a thorough search should always be made in the dental region for focal infections. While extensive pyorrhea alveolaris is frequently responsible for ocular disturbances, blind dental abscesses have proved to be the source of the infections in many instances in which the symptoms were at first attributed to the presence of pyorrhea. Crowned teeth are frequent offenders in the production of inflammatory states of the eye and should always be regarded with suspicion. In every investigation for focal infections in the dental region, the x-ray examination should include all teeth. A negative roentgenogram of simply suspected teeth is not sufficient to exclude dental sepsis. While the uveal tract is the most frequently involved ocular structure as a result of lesions in the teeth, the fact should not be lost sight of that every tissue of the eye can be affected from oral septic conditions. In the present state of our knowledge vaccine therapy in this class of cases has proved to be disappointing, and further investigations will be needed to demonstrate its value.

An ocular syndrom of dental origin. Under this title, H. H. Martin (*Southern Med. Jour.*, March, 1909) gives the history of a banker, aged 49, who came complaining of imperfect vision and a floating opacity in the right eye. Examination revealed no lesion in any part of the uveal tract; pupil reactions were normal; vision with correction (compound myopic astigmatism) was O. D. 20/50, O. S. 20/20; the fundus was clearly visible and was normal in appearance. The vitreous in its posterior two-thirds was perfectly clear, but the anterior third with a plus 20 lens was quite cloudy, showing numerous small granular and filamentous floating opacities, visible only with a plus 20 lens; and one large tadpole-shaped floating opacity visible without magnification.

Examination of the field revealed no scotomata, but there was a marked irregular concentric contraction for white. The color field was not taken. Tension was normal. Wassermann, von Pirquet and urinalysis were all negative, and the only focus of infection that could be demonstrated was at the apex of the right upper incisor tooth, which was inanimate as the result of removal of the pulp some years previously. The tooth was extracted and was found to contain pus, the pulp cavity being filled with a thin, foul-smelling fluid in a small apical abscess.

Three days later, without any treatment other than atropin and suitable protection for the eye, the vision had improved to 20/30 and the field was very much improved; the cloudiness in the anterior

third of the vitreous was rapidly clearing and the single, large, floating opacity was visibly disintegrating. This improvement continued without interruption until August 20, when the vision was 20/20 and the field was normal; with one single floating opacity (the remains of the large tadpole-shaped opacity mentioned above) visible with a plus 10 lens. During this time the left eye remained entirely unaffected.

On Nov. 1, 1918, the patient returned with precisely the same clinical picture in the same eye. Examination revealed marked tenderness over the site of the former dental lesion with two minute fistulous openings through the roof of the mouth just posterior to the former site of the right upper incisor; also there was a transitory glycosuria, which disappeared in a short while and which, in the writer's opinion, was due to overindulgence in sweets and had no connection whatsoever with the eye condition. The vision was 20/40 and the field was contracted.

On November 3, the dental lesion was exposed and thoroughly curetted. A small alveolar sequestrum was found and removed.

On November 4, the very next day, vision had improved to 20/30; and on November 6, three days after the operation, the field had been restored, and the exudates in the anterior third of the vitreous were visibly clearing.

The patient was discharged December 30, with 20/20 vision and a restored field.

The unusual features in this case were the contracted field, the sharp limitation of exudates to the anterior third of the vitreous and the promptness with which all symptoms began clearing up on the removal of the cause—clearly the dental lesion.

The writer very properly claims that the prompt disappearance of the ocular disturbances in this case should encourage us in similar cases to devote our time and energies to a diligent search for a definite causative factor rather than deluding ourselves and diverting our patients by indiscriminate treatment.

A very good *bibliography* is furnished by W. G. Harrison (*Am. Journ. of Ophthalmology*) to the end of 1917 in his paper on the *rôle of teeth and tonsils in the etiology of eye diseases.*

Teeth, Eye. The two upper canine teeth.

Teeth, Fournier. A dental condition often present, like Hutchinson teeth (see p. 6068, Vol. VIII, of this *Encyclopedia*), in parenchymatous keratitis. See **Keratitis, Parenchymatous**, in the last third of the section.

Teeth, Grooved. Barred teeth. Same as Horner's teeth.

Teeth, Horner's. Grooved incisors, from a defect in the enamel; generally attributed to nutritional defects the result of a scrofulous or other dyscrasia.

Teeth, Hutchinsonian or Hutchinson's. PEGGED TEETH. A malformation of the teeth, especially permanent upper central incisors, generally present in children having hereditary syphilis, in which the teeth are short, narrow from side to side at their edges, very thin, and displaying a central cleft on their free edge. See, also, p. 6068, Vol. VIII of this *Encyclopedia.*

Teeth, Notched. The appearance of Hutchinson's teeth (q. v.) when the medial peg is worn away.

Teeth, Pegged. PEG-TOP TEETH. See **Teeth, Hutchinsonian.**

Teeth, Pitted. Teeth, in which, owing to deficient development of dentin or enamel, pits occur on the surface.

Teeth, Screw-driver. Same as Hutchinson's teeth.

Teichopsia. SCOTOMA SCINTILLANS. A luminous appearance before the eyes, with a zigzag, wall-like outline. See **Migraine**; also **Fortification spectrum,** p. 5276, Vol. VII of this *Encyclopedia.*

Teinoscope. A prism telescope.

Teissier, Clair Jean Alexis. A French physician and obstetrician, who devoted considerable attention to diseases of the eye. Born about the beginning of the 19th century, he received his medical degree at Paris in 1827. He practised in Troyes, where he became Professor of Obstetrics and Director of the Obstetrical School. He died as the result of an infected operation wound July 20, 1851.

Teissier's chief ophthalmologic writing is entitled "Observ. d'Amaurose Incomplète avec Héméralopie, Lue a la Soc. Anat." (*Rév. Méd. Franç. et Etrang.*, III, 1833).—(T. H. S.)

Telangiectasia of the eye. TELANGEIECTASIS. A dilatation of the extremities of the blood-vessels or of the capillary vessels.

Telangiectasis of the lids. See **Eyelids, Angioma of the,** p. 4991, Vol. VII of this *Encyclopedia.*

Telangiectasis of the conjunctiva. See p. 3071, Vol. IV; and p. 5759, Vol. VIII of this *Encyclopedia.*

Telangiectasis of the sclera. This is a very rare tumor. An example is described by Quaglino (*Annali di Ottalm.*, Vol. 2, 1872).

Telangiectasis of the choroid. See p. 2168, Vol. III of this *Encyclopedia.*

Telangiectasis of the orbit. See p. 466, Vol. I, as well as p. 9112, Vol. XII of this *Encyclopedia.*

Teleangeiectasis oculi. (L.) (Obs.) Cirsophthalmia.

Teleater. An optical instrument for distinct vision at a distance. Ziegler (*Annals of Ophthalm.*, p. 594, July, 1912) has exhibited the

Zeiss teleater prism glass with loupe attachment, which he regarded as having a distinct advantage over the ordinary loupe commonly used.

Telecentric. Said of an optical system in which the emergent principal rays are made parallel to one another by placing a stop at the first principal focus. See **Wessely's keratometer.**

Telechrome, Bucton's. A combination of the worsted and lantern tests for color-blindness. The contrivance is fitted with disc-carrying glass plates, which by gaslight show the following colors: pale grass-green, pale-rose, bright-red, bright-blue, signal-green, and yellow. The instrument is placed in a darkened room, fifteen feet from the patient, who remains in the daylight and matches the test skeins with the colors as they are displayed in the lantern, under varying degrees of light intensity.—(C. P. S.)

Teleiconograph. TELICONOGRAPH. A telescope combined with a camera lucida.

Telelograph. A semaphore signalling apparatus.

Telegraphoscope. An instrument, involving the use of selenium (q. v.) cells for transmitting a picture or image of an object by telegraph. See **Television.**

Telengiscope. A combined telescope and microscope.

Telephone in eye surgery. The possibilities of the telephone in ophthalmology are stated by Sir Mackenzie Davidson (*Lancet*, Jan. 30, 1915; *Ophthalmoscope*, p. 435, Sept., 1915) in the course of an address on the use of the telephone in the detection and removal of metallic foreign bodies lodged in the tissues, with special reference to bullets. He makes some special remarks regarding the possible use of the method for the removal of non-magnetizable metallic foreign bodies in the eye. As yet no actual opportunity had occurred for testing the method on foreign bodies actually within the living eye; but a very distinct sound is produced in the telephone on contact with the minutest metal particle; even an almost invisible particle would give a sound. Davidson's idea is that the particle should first be localized by the x-rays, and then its removal attempted with the aid of the telephone. He holds out little hope of dealing with a body in the vitreous, since contact would be difficult to secure. The author has proved this on dead animals' eyes.

The proposed method seems to open out interesting possibilities in those very hopeless cases where a non-magnetizable metallic body penetrates the eye and cannot actually be seen.

Telephone operator's eyes, The. This subject is discussed in a Press Bulletin of the Am. Med. Assocn. The writer points out that there are in the United States about 125,000 telephone girls, whose aver-

age term of service is three years or less. The working hours are about eight per diem.; the average number of calls is about 140 per hour, running, "at the peak," to 225 or more. The operator sits facing a switchboard which is covered with numbers, each number having a small signal light that flashes on and off as the call is completed. When the person calling raises his receiver, a light flashes on the switchboard at "central," and this light continues to burn until the operator "plugs" the number and receives the call. She then plugs the number called for and this light burns until the called person raises his receiver from the hook. When the receivers are finally replaced on their hooks, both lights flash and burn until the operator removes the connecting plugs. To complete one call means four flashes of light. As the average number of calls is 140 per hour, with 225 or more during the rush hours, the operator's eyes are exposed to from 500 to 1,000 flashes of light every hour, resulting in fatigue to the eyes, to say nothing of the mental and physical strain under which the operator constantly works. The Bell system, in 1911, spent $720,953 for rest-rooms and lunch-rooms for the operators, and it has secured sufficient air space and good illumination, yet, although only young and healthy girls are selected, the average length of service does not exceed three years. The symptoms of eye-strain which the girls develop are headache, dullness, indigestion, exhaustion, nerve-strain, insomnia, colds and so forth. The two or three short years of telephone work possible to the girls, as well as nine-tenths of all their suffering, is probably due to the constant near-range eyework, without proper protection for the eyes.

Telephote. An instrument for the reproduction of optical images at a distance, as by means of electricity.

Telephoto. A combination of lenses by which a large image of a distant object is produced in a fashion not attainable by the ordinary camera.

Telephotograph. (a) A photographic image produced through the agency of a telephote. (b) A photograph produced by means of a telephotographic camera.

Telephotographic lens. Essentially a combination of a positive with a negative lens system, as in the opera glass, by means of which an equivalent focal length is obtained greater than the distance between the first lens surface and the image plane.

Telephotography. The art of photographing distant objects by means of a telephote or a telephotographic camera.

Telepolariscope. A combined telescope and polariscope.

Teleradiophone. A radiophanic telephone.

Telescope. This well known optical instrument usually consists essentially of a lens or mirror, to form within our reach a real image of a distant object suspended in space; and a microscope, to examine this image in detail. Anticipations of the telescope have been claimed for Roger Bacon (d. 1294?); and Sir Richard Burton alleges that long ere this it was known to the Arabian scientists. Leonard Digges, an English mathematician (1571), speaks of "the miraculous effects of perspective glasses," and must be held to have at least anticipated the invention. Della Porta (d. 1615) may have made a rude telescope. But the telescope from which all later ones proceed by lineal descent seems to be that presented to the General States of Holland on October 2, 1608, by the optician Hans Lippersheim, or Lippershey, of Middleburg. Galileo, hearing of the Dutchman's invention, made a telescope for himself, with which, the first night he used it (January 7, 1610), he discovered three of Jupiter's moons. Kepler (1611) is the inventor of the astronomical telescope.

The reason why it is necessary in a telescope to produce a real image which may itself be subjected to examination by means of a lens is the following: If a single magnifying lens, or an equivalent combination of lenses, be placed between a distant object and the eye, the image formed will not be thrown upon the retina itself, and nothing will be distinctly seen, unless indeed the eye is taken far enough back to see the minute real image itself. If on the other hand, a real image be projected in space within our reach, a magnifying lens or combination of lenses can be made to examine that image as if it were an object, after the fashion of the microscope. If the eyepiece be equivalent to a single magnifying lens or simple microscope, the inverted real image will not appear to be re-inverted, and then what the eye sees on looking through the combination is an inverted magnified representation of the distant object, as in the astronomical *refracting* telescope; but if it be equivalent to a compound microscope, it will appear to re-invert the inverted real image under examination, and will thus furnish an uninverted representation of the object, as in the terrestrial telescope. The astronomical form is thus simpler than the terrestrial and absorbs less light; and it is accordingly used for sailors' night-glasses. If the real image be formed by a concave mirror, a plane reflecting surface or secondary mirror may be interposed so as to turn back or turn aside the reflected rays before they have actually formed the real image, and thus to cause the real image to be produced in some place where it can conveniently be examined by a magnifying eyepiece. If the reflected rays be turned aside through 90° by a plane reflecting sur-

face, the magnifying eyepiece will be at the side of the instrument; and then we have the Newtonian form of the astronomical *reflecting* telescope, exemplified by Lord Rosse's telescope. If the reflected rays be simply sent back along the axis of the instrument, we have the Gregorian form of the reflecting telescope. If the concave mirror be tilted slightly to one side it will bring the real image towards one side of the apparatus, where it may be examined. This is the Herschelian form of the instrument.

When a telescope is in "focus" a pair of cross-fibres, placed in the focus of the eyepiece will appear to retain a fixed position with regard to any point of the object as seen through the telescope, even though the eye of the observer be moved up and down or from side to side. This is called the parallactic method of focusing. By substituting for a given eyepiece others of different magnifying powers, the magnifying power of a telescope as a whole may be varied. The magnifying power of a telescope is the ratio between the focal length of the objective and that of the eyepiece.

The opera-glass is often described as a form of telescope under the name of Galileo's telescope; and, while it does not magnify greatly, it is very serviceable in collecting much light and brightening the field.

As to the unavoidable imperfections of the telescope lenses, both object-glasses and eyepieces have the defect called spherical aberration. But, as a rule, the most conspicuous fault of single lenses is their *chromatic aberration*, which arises from the different refrangibilities of the various colored rays, and leads to the formation, by a lens, of separate overlapping images of a bright object for each colored ray. The remedy consists in *achromatizing* the lens, i. e., forming it of two or more lenses of different kinds of glass, so that the colors, separated by one, shall be reunited by the others. The curvatures of the lenses which make up the achromatic combination, and the distances between them, may be so chosen as to minimize the effects of spherical as well as of chromatic aberration.

Before the discovery of the possibility of forming an achromatic lens Huygens, Cassini, and others had endeavored, by enormously increasing the focal length of the object-glass of the common astronomical telescope in proportion to its diameter, to get rid as far as possible of chromatic aberration. They thus formed the *aerial* telescope, in which the object and eye lenses were mounted separately on stands; the tube (which would have been 100, 200 or even 600 feet long) being dispensed with.

The process of Liebig for depositing on glass an exceedingly thin

film of silver, which, by careful polishing, can be rendered more highly reflective than any other material, has been taken advantage of by Steinheil in the construction of large specula for reflecting telescopes. —(*Standard Encyclopedia.*)

Telescope eye. A gastropod eye—on a retractile stalk. See **Comparative ophthalmology.**

Telescope fish. A variety of the gold fish (*Carassius auratus*) with very protuberant eyes.

Telescope fly. A tropical fly of the genus *Diopsis,* having the eyes on long prolongations at the side of the head.

Telescope-sight. A small telescope mounted as a rear sight on the barrel of a fire-arm or a piece of ordnance.

Telescope spectacles. Hans Lauber (*Arch. f. Ophthal.,* 89, p. 401, 1915) describes these glasses (Fernrohrbrillen). Each eye of the spectacles consists of 2 lenses, mounted at a small distance from each other in such fashion that the anterior lens can be removed from the posterior lens, whereby the refraction of the whole optical system is increased. The refraction can be varied four dioptries, which suffice for the practical use of a person deprived of accommodation. He thus can accommodate for any distance from infinity to 25 cm. The field of fixation is limited to 24°. The spectacles weigh 43 grams. They are adjusted by one screw, and the mechanism assures simultaneous correct convergence, imitating the normal process.

Stoll (*Oph. Year-Book,* p. 67, 1912) describes and advocates the use in high myopia of Hertel's telescopic spectacles. These were devised to increase the visual acuity, which usually remains low even after correction in high myopia, by magnifying the images. The combination consists of a convex objective with a concave ocular as in the Galilean telescope. A magnification of 1.27 has been found to give about the best results. Greater magnification entails too great limitation of the visual fields, although in individual instances where the vision is very low increased magnification may be advantageous. The instrument looks like automobile goggles, but is less conspicuous. Their weight is 36 grams—8 grams more than old fashioned cataract spectacles. Hertel objects to the ordinary biconcave lenses in that they entail an astigmatism of the oblique pencils, in consequence of which the field becomes ill-defined and distorted at a small distance from the center of the glass.

These new telescopic spectacles will probably be a welcome addition to the oculist's armamentarium in a certain proportion of cases (see below). But we believe that a nicely ground and properly chosen correction of the myopia and accompanying regular astigmatism,

well mounted and adjusted, will give at least as satisfactory results in the majority of cases as this more complicated apparatus. It is believed that the experience of American oculists will amply bear out this statement. Much depends, of course, upon proper centration and mounting.

K. Scott (*Ophthalmology,* p. 422, Vol. IX, 1913) has mounted Hertel's telescope spectacles as a single lens in the ordinary spectacle frame. The lenses are only in contact at their edges and enclose an air space between their opposing surfaces. The heavy frame-work mounting has been entirely eliminated. The effect of this improved form of glasses is to give markedly greater freedom from aberration, including distortion, and having the appearance of ordinary glasses, they are quite as light to wear.

Telescopic magnifiers. See **Magnifier, Telescopic,** p. 7584, Vol. X of this *Encyclopedia.* In addition to the magnifiers there described Zeiss has advertised a binocular telescopic magnifier which consists of a three-power Zeiss prism glass similar to the so-called teleator, having added thereto an amplifying lens attachment by means of which a magnification of 4 diameters may be secured with a free working distance of 9 cm. The lens attachment is removable, and permits the use of the glass as a field or theatre glass, as may be required.

The magnification, free working distance, flat field and achromatism make this a combination useful in medical, biological or minerological investigation and fine mechanical work. See the figure on next page.

Telescopic vision. Tubular vision. That in which owing to a narrowed visual field (generally contracted to within a few degrees of the fixation point) the patient sees, as if through a tube or hollow cylinder. It occurs in certain forms of concentric optic atrophy—in the late stages of retinitis pigmentosa, for example.

Telespectroscope. A telescope combined with a spectroscope.

Telestereograph. An instrument by means of which the outline of drawings, photographs, pictures, etc., may be reproduced at a distance by means of telegraphy.

Telestereoscope. Mirror stereoscope. A stereoscope for viewing distant objects through the artificial increase of the interocular distance by means of four plane mirrors so fixed in a box as to admit of slight rotation, and thus to bring the images into coincidence. See under **Stereoscope** at the beginning of the section.

Teletopometer. A range-finder, in which two telescopes are employed.

Television. This process (seeing by wire from a distance) has been brought to practical operation. Two exhibitions of crude television

have been given recently—one before a British learned society by Dr. A. M. Low, and the other before the Academy of Science, in Paris, by a French scientist. A third inventor displayed before the Royal Society, in London, a device that almost solved one of the most

Zeiss Binocular Telescopic Magnifier.

difficult problems—the original recording of the scene to be transmitted by wire.

From these laboratory experiments it is a long step to showing, *e. g.*, the world's champion baseball games on moving-picture screens in every city of the United States while the games are in progress. Never-

theless, the step may be taken before many more championship series are played.

The French machine, constructed by Georges Rignoux, a brilliant young physicist of La Rochelle, follows the same general principles that have been tried in most of the television devices since inventors began to work on the problem, many years ago. He has succeeded in sending pictures of letters of the alphabet by wire.

A letter placed before the receiver of his machine instantly appears on a screen at the receiving end, in the next room or miles away; and, no matter how rapidly the letters are changed, if not too rapid for the eye, the screen shows the change.

Rignoux uses a camera with the usual lens to record the scene he wishes to send, the letter A for instance. In the back of the camera. instead of a film or plate, are sixty-four cells—eight rows of eight each. Each of these cells is made very sensitive to light by means of selenium. The amount of electricity that will pass through a bit of selenium varies according to the amount of light thrown on it; so each of the sixty-four cells is in a separate circuit.

When the camera points to the letter A the black form of the letter shades some of the cells, while other cells catch the light from the white paper on which the A is printed. Every one of the sixty-four cells then reports, by means of its separate current of electricity, whether it received a black impression or a white impression.

The picture, in other words, has been divided into sixty-four points. If the light value of each of these sixty-four points is reproduced on a screen at the other end of the wire, each point in its right place, there will appear on the screen a letter A, made of a number of dots instead of solid lines.

Any half-tone illustration in a magazine or newspaper will show how the dots can be made to make a picture. Examination of a newspaper half-tone will show something like four thousand of these dots to a square inch, the dots varying in blackness. This part of Rignoux's machine follows the usual method. Low's camera is much the same.

Next, it is necessary to telegraph to the receiving station the light value of each of these sixty-four dots. It could be done easily by having sixty-four sets of wires, but that would mean the whole effort would be impracticable whenever an attempt was made to send a large and clear picture, which is evident from the fact that newspaper pictures use four thousand dots to a square inch. Rignoux, however, has devised a collector which takes a report on each of the sixty-four cells in turn, and sends it to the receiving station so rapidly

that all sixty-four are sent without confusion many times a second; and only two wires are used.

At the receiving station there is a screen, in darkness, on which is thrown, from a set of mirrors, a succession of light beams. Each light beam goes to its own special place on the screen, each being controlled by one of the sixty-four cells in the camera at the other end of the wire. All sixty-four points are flashed on the screen so rapidly that each has several flashes a second.

By the phenomenon of retention of vision on which moving pictures are based, all sixty-four points seem to be receiving light at the same time instead of one by one, in turn; so the screen shows, by dark dots and light dots, just what the camera is seeing at that same instant.

Low's cells send half lights reasonably well; but another British scientist, L. H. Walter, has found a way to do it very well. What is more, he seems to have found a way to concentrate a great number of these cells in a small space. By his method four thousand dots to a square inch ought to be possible. Instead of using selenium he has made up cells of chemicals and metal which are vastly more sensitive than selenium to changes of light intensity. Furthermore, instead of a separate cell for each dot he uses one multiple cell which will report the light intensity of each dot on its surface. (Abs. from *Sat. Evening Post*, Dec. 17, 1914.) See **Telegraphoscope**.

Telorasis. (L.) An old name for presbyopia.

Temperature in ocular conditions. Very little has been written on this subject. Of the literature the essay (The Body Temperature in Ocular Affections) of Igersheimer (*Zeitsch. f. Augenh.*, Vol. 29, Part 1; Abst., *Woch. f. Ther. u. Hyg. des Auges*, April 3, 1913) is the most practical. He finds that aseptic incisions of the globe do not influence body temperature. Postoperative infections, hypopyon, panophthalmitis, elevate body temperature, which after exenteration returns in several days gradually to normal. Non-purulent, intraocular inflammations have no influence on body temperature. Purulent affections of the cornea are usually accompanied by a rise of temperature—subfebrile—which returns to normal with the healing of the ulcer. The temperature is not proportional to the severity of the ulcerative process. Experiments show that the rise is not due to the bacteria *per se*, but to their products, which gain access to the anterior chamber. In the human eye the process is probably analogous.

Howe (*Oph. Year-Book*, p. 102, 1913) has devised a thermocouple for the conjunctival sac. As a result of measurements made in the cocainized sac of man, he states that the temperature of the cul-de-

sac near the outer or inner canthus is usually about 0.3 to 0.4 C. lower than that of the mouth. Over the cornea the temperature was 0.1 C. lower than at the outer or inner canthus. The application of cold compresses to the lids for 4 or 5 minutes reduced the temperature 1 to 1.5 C. He believes that the apparatus may prove of value in indicating the change of temperature which accompanies certain inflammatory diseases of the eye, and in determining the metabolic changes that take place in that complicated process called eyestrain.

Cirincione (*La Clinica Oculistica*, Mar., 1913, abstr., *Ophthalmoscope*, p. 21, Jan., 1915) finds that the *indices of the ocular media vary with the temperature*. He shows that the temperature at which the humors are examined has a very important bearing on the index, and from this he draws the conclusion—which seems justified—that all preceding measurements which have not taken this factor into account, are inexact.

He shows that the index of distilled water varies from 1.3331 at a temperature of 16° C. to 1.3300 at a temperature of 41° C. and that the neglect of the factor of temperature accounts for the variations in the estimates made by previous observers. He comes to the conclusion that, when the aqueous is measured soon after death at the normal body temperature, it is homogeneous and has a stable index, but that the index varies according to the temperature and the time after death. The vitreous is also homogeneous. The cornea, however, has various layers having various indices, but the parts are so compactly held together and the form is so stable that no error is likely to follow the adoption of a single index for the whole cornea. The lens is even more variable; the most refractive part, the nucleus, is situated rather behind the centre of the lens, towards the posterior surface. The strata of the lens vary in index according to the age of the animal; no other of the refractive media show any similar variation.

As a result of his measurements of human structures, Cirincione concludes that the human aqueous and vitreous do not vary appreciably from those of animals, the index of the aqueous being 1.33325, and of the vitreous 1.33312.

The cornea is, on the other hand, higher in refractive index than in other animals; in man this index is 1.3731.

The various strata of the lens show marked differences of index, and the changes in age are, probably owing to the long life of man, more marked than those found in animals. See, also, **Thermoscope.**

Temperature regulator, Leiter's. Under the better known name of *Leiter's coils* (see p. 5725, Vol. VIII, and p. 7190, Vol. IX, of this

Encyclopedia) this useful apparatus is described and pictured. See, also, the cut in this text.

Leiter's Coils or Temperature Regulator.

Temples. Temple pieces. See p. 4953, Vol. VII of this *Encyclopedia.*

Temple-sleep, Treatment of the eyes by. See **Ophthalmology, History of.**

Temporal canthus. Outer canthus.

Temporal crescent. This is a term applied by Behr (*Klin. Monatsbl. f. Augenheilk.*, Vol. 56, pt. 2-3, 1918) to the outer rim of the temporal field of vision of the eye which extends beyond the nasal field of the other eye when the perimeter chart of one eye is laid upon that of the other.

Temporal diplopia. Homonymous diplopia.

Temps de pose. (F.) Exposure.

Tendency to ocular disease. See **Disposition,** p. 4040, Vol. VI of this *Encyclopedia.*

Tenderness of the eyeball. Ciliary tenderness. The diagnostic significance of tenderness in the ciliary region is discussed by Thomson (*Oph. Year-Book*, p. 21, 1909). He finds that it may be due to cramp of the fibres of the ciliary muscle. Tenderness of the kind, for example, has been found in astigmia. It may also arise from hyperemia without cyclitis. Duane has pointed out that a tender point in the tarsus of the upper lid, occurring with conjunctivitis or in some rheumatic conditions, may be mistaken for ciliary tenderness.

Tendon folding. See p. 8220, Vol. XI of this *Encyclopedia.*

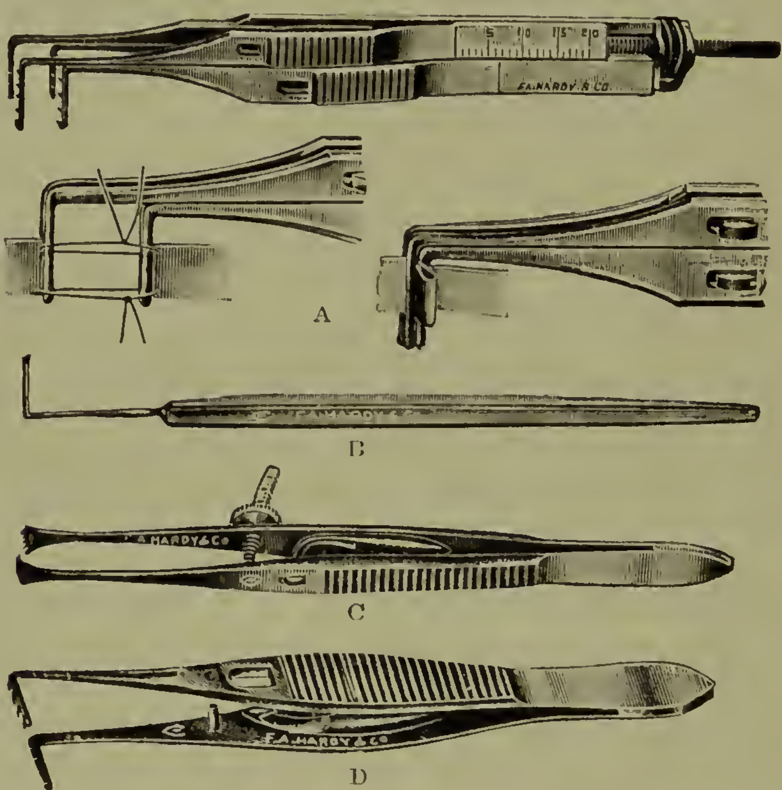
Tendon hook. See p. 6000, Vol. VIII of this *Encyclopedia.*

Tendonometer. See the first portion of **Muscles, Ocular.**

Tendon resection. See p. 8233 Vol. XI of this *Encyclopedia.*

Tendon shortening. This method is fully discussed on p. 8232, Vol. XI of this *Encyclopedia.* Here a few instruments for the purpose are depicted.

Tendon transplantation. See p. 8237, Vol. XI of this *Encyclopedia*. In addition, it may here be said that H. W. Woodruff (*Ophthalm. Record*, Nov., 1917) describes his method of operating in a case of *paralytic convergence*, as follows: The patient was a girl, aged 20, who attributed her paralysis to a fall on her head. When 15 years of age she had had an advancement of the paralyzed muscle with tenotomy of the internus. This, she thinks, had improved her condition to some degree. About a month before she had had another tenotomy of the internus.



George's Instruments for Tendon Shortening, Advancement and Tucking. A. Recession and Tucking Forceps; B. Right Angle Tendon Hooks; C. Tendon Tucker; D. Tendon Forceps.

At the time of her admission to the hospital, she had 20 degrees of convergent strabismus when looking straight forward, but only the slightest perceptible movement of outward rotation.

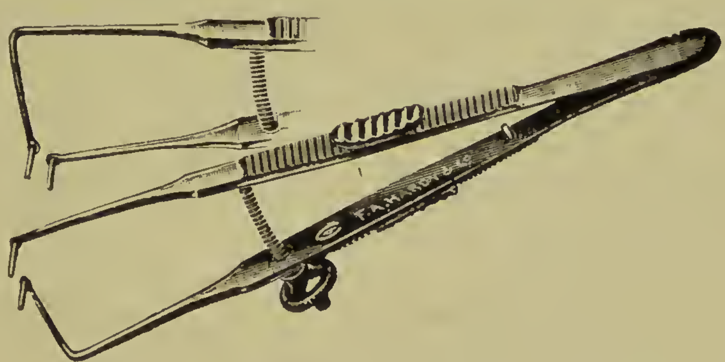
Woodruff proceeded, after Hummelsheim, to transplant the whole of the tendons of the superior and inferior rectus muscles to two points on the globe midway between the superior rectus and the externus, and between the inferior rectus and the externus, respectively.

Anesthesia was secured by subconjunctival injections of novocain and epinephrin over the sites of the four rectus muscles. The tendons of all four muscles were exposed by incisions through the conjunctiva

and capsule. The outer halves of the tendons of the superior and inferior recti were separated for about 12 mm., and each tendon flap was sutured to the tendon insertion of the paralyzed muscle with 00 catgut treated with formaldehyd. The internal rectus was freely tenotomized and the conjunctival wounds closed with silk. Both eyes were bandaged for three days. The eye operated on was bandaged for one week. There was distinct improvement but still a slight convergence. This the writer attempted to relieve by shifting the remaining normally attached portion of the superior and inferior recti to positions slightly outward so that they would no longer act as adductors. This secondary operation was of doubtful success.

To the foregoing it may be added that Hummelsheim (*Oph. Year-Book,* p. 105, 1909) transplanted the temporal halves of the superior and inferior recti to relieve paralysis of the abducens, with satisfactory results. The abductive power remained considerably below the normal, but the diplopia was entirely cured.

Tendon tucker. In the subsection on this subject, p. 8229, Vol. XI of this *Encyclopedia*, the operation of Greene and others is described.



Green's Tendon Tuckers. (Right and Left.)

Here the instruments of the former are more fully depicted, and his improved technique is given (*Ophthalm. Record,* Dec., 1909). A shoulder has been made on Greene's tendon tucker at the junction of the blades and tines, which prevents the tendon slipping back upon the blades. The tines are made at perfect right angles to the blade, and of even size from shoulder to point, so as to prevent rotating the eye up and down in making the tuck. The milled nuts are both worked from the right hand side so that in facing the patient the right hand can be used in its adjustment.

The author has improved the technic of the operation as follows: The skin of the face and lids having been cleansed and the conjunctival sac rendered sterile, the tissues are anesthetized by a 4 per cent. solution of cocain dropped into the eye and a 2 per cent. solution

injected beneath the conjunctiva in the field of the operation. Inserting the speculum, the lids are widely separated. Raising the conjunctiva with fixation forceps, with curved scissors a semicircular flap is made from near the corneal margin, extending the upper and lower angles of the incision back as far as Tenon's capsule, thereby forming a flap sufficiently wide to give free access to the rectus tendon and to be out of the way of the tines of the tucker, which are about 8 mm. in length. The flap is dissected back, exposing the clean tendon. The blades of the tucker being widely separated, the tine of the straight blade is passed beneath the tendon from above, the tine of the angular blade resting upon the tendon near its insertion. Now by gradually turning down the milled nut or pressing together the blades, the tine on the angular blade is carried beneath the tine on the straight blade, carrying with it the tendon, thereby making the tuck and rotating the eye to the desired position. An assistant now holds the tucker while the operator introduces the suture, which consists of a number 0 or 00 sterile catgut, about eight inches in length, armed with a fine curved needle at each end. The needles are passed from beneath the tucked tendon between the two tines of the tucker, one needle emerging near the upper end and the other near the lower edge of the tendon. The suture is now tied in a surgeon's knot across the fibers of the tendon and the tines of the tucker withdrawn. The blood is thoroughly removed from the operative field, the conjunctival flap replaced and secured by two or three small stitches of fine, iron-dyed silk. The lids are now brought together and cold water compresses kept on for a few hours.

Tendon tucking. See p. 8222, Vol. XI of this *Encyclopedia.*

Tendo oculi. TENDO PALPEBRÆ. LIGAMENTUM PALPEBRALE INTERNUM VEL MEDIALE. See p. 348, Vol. I of this *Encyclopedia;* as well as the illustration on page 347.

Tenebrific. Producing darkness.

Tenebrose. TENEBROUS. Dark.

Tenia. The typical genus of the *Tæniada,* or *Tæniadæ* (Ger., *Bandwürmer*), which are a family, order, etc., of the *Cestoda,* characterized by a distinct head (or attached extremity) with four suctorial discs with or without a double or single row of hooks, and by a band-like body divided into segments, which, when mature, are bisexual. The adults inhabit the intestinal canal of vertebrates, nearly every genus of which has its specific tenia. In their larval state *(cysticercus)* they are found in both vertebrates and invertebrates. See, for example, **Tenia solium**; as well as under **Parasites, Ocular,** p. 9280, Vol. XII of this *Encyclopedia.*

Tenia echinococcus (scolecipariens). A small species inhabiting the dog and the wolf. The larva is the *echinococcus* of man. It is seldom more than ¼ inch long, and has only four segments. The head has a double row of hooks, thirty to forty in number, and four suckers. See p. 4123, Vol. VI of this *Encyclopedia.*

Tenia mediocanellata. BEEF TAPEWORM. This species was formerly regarded as a *Tenia solium,* but it differs from that in being larger and having a non-unciate head, with four large suckers surrounded by dark spots. Its cysticercus (*cysticercus bovis*) inhabits the muscles of cattle.

Tenia solium. SOLITARY (OR ARMED, OR PORK) TAPEWORM. This animal is an entozoon found in the intestines of man. In its mature condition it is said to have attained the length of over sixty yards. It has a globular head of about the size of a pin-head, provided with a double row of hooks and with four sucking discs. The neck is about half an inch long and continuous with the body, which is at first marked with transverse lines that, gradually separating more and more, leave interspaces. These parts finally become distinct segments which when mature are twice as broad as they are long, and are each provided with complete male and female organs of generation. After impregnation of a segment, embryos are developed in its interior, and it passes out of the intestine, when the embryos are scattered by its rupture. The embryos, still in their envelopes, are swallowed by a pig, where they rupture their shells and bore into the tissues of their host, causing "measles." There, losing their hooks, they are quiescent, and are known as the *cysticercus cellulosa.* After being ingested by man, they develop hooks, and, having attached themselves to the intestinal walls, begin to grow, increasing at the free extremity until they assume the above-mentioned form. (Foster.) See, also, p. 3661, Vol. V of this *Encyclopedia.*

Tennis, Lawn, Ocular requirements of. See **Sport.**

Tenometer. TENONOMETER. TONOMETER. An apparatus for measuring intraocular tension. There is no authority for the first spelling of this term. See **Tonometer.**

Téno-myotomie. A term applied by Abadie to an operation for enfeebling one of the recti muscles of the eye. It consists in incising the lateral parts of its tendon near its scleral insertion, and in excising a small portion of the muscle on each side.

Tenonitis. INFLAMMATION OF THE OCULO-ORBITAL FASCIA. Inflammation of Tenon's capsule is sometimes found as a distinct affection; generally as a part of severe orbital cellulitis, in which case, however, it is scarcely to be differentiated from the more general inflammatory process.

The *symptoms* include slight or moderate swelling and edema of the upper lid which, on account of the firm attachment of processes of the orbital fascia to the upper margin of the tarsus, may be more marked in the lid above the tarsus. Chemosis, pain on motion, and restricted movement of the eyeball, with some proptosis, are present. These symptoms are all found in orbital cellulitis, in which condition they are generally more pronounced. The most characteristic symptom of tenonitis, and the one which, when present, establishes the diagnosis, is the occurrence of vesicular swelling over the insertion of one of the straight muscles. It will be remembered that the straight muscles pierce Tenon's capsule by a kind of invagination, thus offering a favorable situation for the pushing forward of serous fluid collecting within Tenon's space.

Etiology. Tenonitis may follow operations directly disturbing the capsule, such as tenotomies and advancements. It is then usually severe and, if suppurative, endangers the integrity of the eyeball. Bull mentions a case known to him of double panophthalmitis resulting in blindness from a simultaneous tenotomy of both internal recti muscles. Such a calamity sounds a note of warning against the slightest carelessness in the performance of these operations, however simple and usually free from danger they seem to be. Zentmayer reports tenonitis as a complication in a case of typhoid fever. It has been known to occur after diphtheria and influenza. The most frequent causes of idiopathic tenonitis are rheumatism and gout. These diseases are often responsible for episcleritis, with which certain cases of tenonitis might be confounded. Ordinary care in the examination should make the differential diagnosis clear.

Prognosis of the traumatic cases must be guarded, the danger of panophthalmitis being imminent in any pyogenic inflammation of the capsule. The other cases, as a rule, recover, leaving the parts functionally normal. The duration depends upon the character of the inflammation, and in chronic cases may be many months.

Treatment. If pus is present, free incision into the capsule for its exit must at once be made. This is an important procedure, and must be unhesitatingly accomplished. Salicylic acid, or salicylate of sodium, potassium iodid, or colchicum, is indicated if the cause is rheumatism or gout.—(J. M. B.)

Terson believes that the fibrous sheath which supports the eye, the retro-ocular capsule of Tenon, is liable to share in the disturbance from rheumatism and gout. It reacts then like a synovial membrane: there is inflammatory effusion back of the eyeball and movements of the eyeball are painful. Exacerbations at night suggest a gouty taint.

Both eyes are usually affected. Treatment requires some general analgesia to relieve the pain, followed by measures addressed to the underlying cause.

S. Myashita (*Klin. Monatsbl. f. Augenheilk.*, 49, p. 288, 1910; abs. by Geo. Coats in *Oph. Review*, Oct., 1911) reports cases illustrating the *association of tenonitis with sarcoma of the choroid.* His first case was that of a woman aged 70, who, when first seen, had vitreous opacity and anterior choroiditis. Some months later conjunctival chemosis and redness appeared, with painful movement and slight prominence. At the same time a floating detachment of the retina was found, which disappeared after scleral puncture, etc., but subsequently recurred. About two years after the first symptoms there was a second attack of tenonitis. Shortly afterwards acute glaucoma set in and the eye was excised: the sclera was adherent to the conjunctiva. A flat, spindle-celled alveolar sarcoma was present on the temporal side: vessels were scanty and there was necrosis and hemorrhage; perforation was occurring along both the anterior and posterior ciliary vessels. Around the tumor and in the episcleral tissues, both over it and elsewhere, there was a good deal of leucocytal infiltration.

In his second case, after the patient had complained of a defect of vision for six months, conjunctival chemosis set in, movements were painful and the eye was slightly prominent. A yellow area with darker borders was visible in the choroid on the temporal side. About six months later the tenonitis recurred, and as the area in the fundus now showed more definitely the characteristics of a tumor, the eye was excised. A spindle-celled sarcoma was found in the outer layers of the choroid. There was no invasion of the sclera; no degeneration; only slight signs of inflammation. The tenonitis had entirely disappeared.

Inouye (*Oph. Year-Book*, p. 349, 1912) discusses the *pathology of tenonitis* and cites two cases. In his first case, six weeks after injury by a piece of stone, the patient had severe pain and a bulging of the medial surface of the sclera of the left eye. This was excised and a small quantity of pus escaped. V. = 6/6. Sixteen days later the conjunctiva was swollen and hyperemic, with small necrotic areas at outer limbus; iris hyperemic with posterior synechia. V. = 6/36. Chemosis and pain continued. Tension minus. Vision = counting fingers at 1 m. Enucleation.

His second case had chemosis, high tension, exophthalmos; and complicated a necrotic sarcoma of the choroid. He surmises that the inflammation spread through the perivascular tissue space of the vortex veins to the suprachoroidal space and uveal tract. Toxins were

probably carried from the eye to Tenon's capsule. He admits a possibility of diffusion of toxic products through the scleral tissue to the uvea.

Serous tenonitis. A few cases of this very rare form of the disease are on record. F. Pincus (*Archiv für Augenheilk.*, Vol. 75, pt. 1, 1913; abst. *Oph. Review*, p. 338, Nov., 1913) remarks that Birch-Hirschfeld was able to collect only some 40 cases of the *acute form* and of these several were doubtful and others secondary to such causes as squint operation.

The patient of Pincus was a young man of 20, who went for a long motor journey in a keen wind at night after free indulgence in alcohol. The following day he was slightly feverish, with headache and swelling of the eyelids. A day later the swelling had increased and the lids were colored a blue-red. There was no history of gonorrhea nor any rheumatic diathesis.

When seen a day later by Pincus the lids were very much swollen and dark red in color with only a small amount of secretion in the corner of the eye, and this was found to contain no micro-organisms. The swelling was sharply limited to the tarsal portion of the lids and did not extend to the brow or nose. The patient was quite unable to open the lids himself, but to the astonishment of Pincus, when passively separated, the lids showed a practically normal inner surface. The bulbar conjunctiva showed much chemosis and the eyeballs were slightly proptosed. The patient was unable to make the slightest voluntary movement of the eyes and the attempt was very painful. The eyeballs felt to the touch as if firmly imbedded in a hard swelling. The cornea and interior parts of the eye were quite normal, as also the vision. Three days later the condition of the eyes was practically normal, but there was some swelling of all the salivary glands and a little tenderness on deep pressure over the orbital glands. The patient did not return for further observation. The treatment employed consisted in the use of hot compresses and massive doses of sodium salicylate.

Mumps affecting the lachrymal as well as the salivary glands has long been known to occur, and this case may have been of that nature. It is unfortunate that the patient was not seen for a sufficiently long period to settle this question. The rapid onset and subsidence serve to separate this disease from those cases of possibly tuberculous origin described by Mikulicz.

A more recent case of *serous tenonitis* in a woman of sixty-seven is reported by G. M. McBean (*Journ. Oph. and Oto-laryng.*, p. 201, 1917). She had a paralysis of the external rectus muscle, with edema

of the ocular conjunctiva. Under the administration of iodides and salicylates it soon cleared up. A month later she awakened with intense chemosis of the left ocular conjunctiva, so that she could not close the eyelid. A Snellen suture through the lid was applied, and the treatment with iodides and salicylates continued, together with multiple puncture of the edematous conjunctiva and a pressure bandage resulted in a cure. His second case was one of orbital cellulitis occurring in a child, 3 years of age, who had swelling of the left eyelid and marked proptosis and a temperature of 102°. There was rhinitis on that side with watery discharge. Deep orbital probing did not reveal any pus. A few days later a swelling formed in the region of the lachrymal sac. No pus was found. Recovery resulted in a few weeks.

Ténon, Jacques René. A celebrated Parisian anatomist, surgeon and ophthalmologist, whose name has been commemorated in the term, "Tenon's Capsule." Born at Scepaux, Ivogny, Feb. 21, 1724, the son of a physician and the eldest of eleven children, he studied medicine at Paris, became a military surgeon, and, after the expedition into Flanders, was elected surgeon-in-chief at the Salpêtrière. He became an excellent operator and a teacher of fair ability. He was one of the first to introduce Jenner's discovery into France, and was foremost in many a scientific undertaking. As a writer, he was often obscure, but his matter was generally important.

His chief performance was what is usually referred to as his "discovery" of the fibrous capsule of the eye. Tenon, nevertheless, did not really discover this capsule. The structure was known quite well to the ancients, who, however, did not describe it minutely or appreciate its importance. Tenon described it with great particularity, and, if he did not discover it, he at least discovered its details. Tenon's work in this respect was largely ignored until the invention of the strabismus operation (1839-'40; see herein **Strohmeyer, Dieffenbach, Wm. Gibson**). In 1841 Bonnet, stimulated by the work of Dieffenbach and Strohmeyer, made numerous and careful dissections of the structure in question, and published the results in his *Traité des Sections Tendineuses et Musculaires dans la Strabisme, la Myopie, la Disposition à la Fatigue des Yeux*, etc. (Lyons, 1841; avec 16 planches.) Bonnet, in this work, describes the capsule so much more clearly and more specifically than Ténon had done that it is quite as generally called today by the name of its better, as by that of its first, describer.

The more important ophthalmologic writings of Ténon are as follows: 1. Recherches sur les Cataractes Capsulaires. (*Mém de l'Acad.*, 1755.) 2. Sur quelques Maladies des Yeux. (*Ibid.*, 1804.) 3. Faits

Pratiques sur Quelques Maladies des Yeux. (*Ibid.*, 1804.) 4. Obs. Succinctes sur l'Oeil du Chathuant et sur celui d'une Baleine. (*Ibid.*, 1806.) 5. *Mémoires sur l'Anatomie, la Pathologie, et la Chirurgie et sur l'Organe de la Vue.* (Paris, 1806. This work contains all of Ténon's former ophthalmologic writings, as well as several new ones.)

It is interesting to note that Ténon's ophthalmologic writings were all composed, or at any rate published, in his old age. He died at Paris, Jan. 16, 1816, aged 92.—(T. H. S.)

Tenonometer. A tonometer (q. v.).

Tenon's capsule. The tarso-orbital fascia. See p. 1392, Vol. II of this *Encyclopedia.*

Tenon's capsule, Advancement of. See p. 8224, Vol. XI of this *Encyclopedia.*

Tenon's space. See p. 1392, Vol. II of this *Encyclopedia;* also under **Anatomy of the eye.**

Tenontotomy. Same as tenotomy.

Teno-plication. This, as described by the writer, A. S. Worton (*Ophthalmoscope*, p. 326, June, 1914), is a *method of advancement, without*

Teno-plication. Flat Tendon Guide with Angled Handle. (Worton.)

resection of the tendon, for convergent squint. It may be used in place of the usual advancement operation combined with tenotomy of the internal rectus, but is of special advantage in cases in which it is desired to do an advancement without simultaneous tenotomy of the opponent muscle. No originality is claimed for the idea itself.

The operation is an "open" one and consists of a simple carrying over of the external rectus tendon together with the conjunctiva and capsular tissue and reattachment farther forward without tenotomy or resection of the tendon.

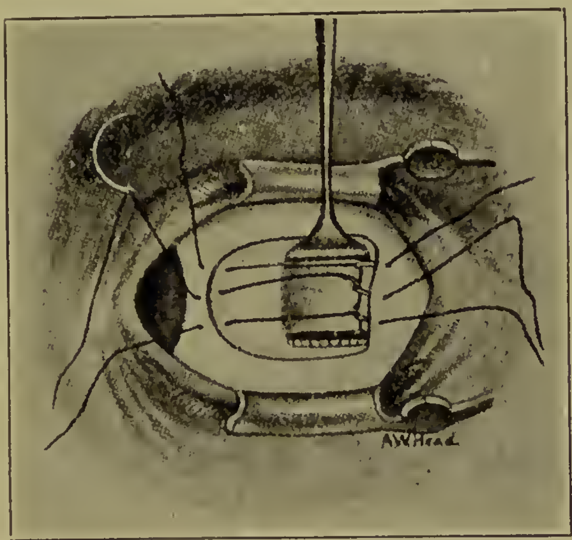
The advantage of leaving intact the original insertion of the muscle is especially evident in simple advancement, since in the event of any slipping, or cutting through of the sutures, usually the result of faulty insertion, the muscle can not fully retract, as is so likely to happen in the usual method of advancement without tenotomy of the internal rectus, owing to the constant traction of the latter muscle.

Provided, however, the sutures are given a deep hold on the sclera at the new anterior attachment, there is little likelihood of their slip-

ping or cutting through here, and owing to the transverse direction in which the sutures are passed through the whole width of the tendon behind, it is practically impossible for them to cut through in this situation. Definite over-correction of the deviation to the extent of from 4° to 5° should be aimed at as the immediate result of operation in those cases in which no simultaneous tenotomy of the internal rectus is done, so as to allow for slight stretching of the new attachment of the muscle.

No over-correction, be it noted, is required when tenotomy of the internal rectus is simultaneously performed on the same eye.

Taking the average length of the external rectus tendon to be about 7 mm., and its scleral attachment about the same distance from the



Worton's Teno-plication. A Method of Advancement for Convergent Squint.

corneal margin, we get a possible shortening of 14 mm. In actual practice the writer has obtained a shortening of 12 mm. From careful measurements of the angle of deviation before and after operation, the writer finds himself in agreement with certain other observers that only 2.5° of correction are to be obtained from each millimeter of shortening, and he now takes the fact as a basis for calculation as to the actual amount of shortening required in a given case.

The effect of the operation is to bury the tendon, which becomes adherent to the underlying sclerotic, thus offering a broad area of resistance to the traction of an untenotomized internal muscle.

The thin, membraneous tendon of the external rectus lends itself admirably to this procedure, and the slight hump produced at the site of folding quickly becomes smaller and disappears at the end of a few weeks.

The angle of deviation should be carefully estimated before operation, on the tangent scale, and the functional condition of the external rectus ascertained. It is obviously unfair to expect a good result from simple advancement in the case of a weak, stretched muscle of impaired abduction power.

The best results by this method are to be obtained from squints of the alternating variety with good vision in each eye and normal muscle movements. The only special instrument required is a flat tendon guide with angled handle on which the tendon lies, and which is made in two sizes, 8 mm. and 10 mm. respectively. It can be used for either eye with equal facility. The larger size is usually employed for adults, the smaller for younger patients, or where there is less room than usual on account of deeply-set eyes or other cause. The outer edge is notched in millimeters, and the guide is flanged so that the tendon lies snugly on it, so that it is practically self-retaining during the operation.

The field of operation is constantly under observation—the guide, when in position, preventing any disarrangement of the parts from any unexpected movement of the patient's head or eyes.

Technique: The patient having been prepared in the usual way, the conjunctival sac is washed out with warm boric lotion, a few drops of a 5 per cent. solution of cocain with 1 to 1000 adrenalin are instilled, and the speculum is inserted.

The operator stands on the right side of the patient's head for the left external rectus muscle, and on the left side of the head for the right external rectus. The conjunctiva is picked up with forceps about 4 mm. from the corneal limbus and reflected precisely as in the usual advancement operation. The parallel fibers of the external tendon are then defined, and with a snip of the scissors a buttonhole is made through the loose, subconjunctival tissue and capsule just above, and then below the margin of the tendon close to its insertion. A tenotomy hook is then passed underneath the tendon and held in the left hand of the operator who then frees, by blunt dissection with the closed scissors, the tendon as far back as necessary to permit of the introduction of the tendon guide. Directly the guide is passed beneath the tendon, the tenotomy hook is withdrawn. An assistant then takes charge of the guide, holding the handle from below in the case of the right muscle, and from above in the case of the left external rectus. This is done to facilitate the passing of the sutures. Three curved needles carrying double threaded No. 1 silk are in readiness, and taking one in a needle holder, the operator picks up the middle of the cut reflected conjunctiva with forceps, and passes the suture through it

and then transversely through the tendon, lying on the guide in such a manner that the middle third of the tendon is included. The emerging thread is passed behind the entering thread of the tendon suture and finally carried forward to the sclera, taking a deep hold here, and on out through the inner cut edge of conjunctiva. The needle in passing through the tendon is made to impinge directly on the guide to make sure that the whole thickness of the tendon is transfixed. The suture when passed as described is then loosely tied for purposes of easy identification.

The other two sutures for the upper and lower thirds of the tendon are passed in similar fashion, taking conjunctiva, capsular tissue, and tendon, and are then brought forward to the scleral attachment and made to include the cut edge of conjunctiva on the inner side. The sutures being passed, the guide is withdrawn. If it be desired to do a tenotomy of the internal muscle it is done at this stage, otherwise the sutures are tightened, the surgeon bearing in mind the desirability of over-correction of the deviation at the time of operation.

Care must of course be taken that the muscle is not advanced farther than the tendon suture will allow, e. g., if the line of tendon sutures is only 4 mm. from the insertion of the muscle the muscle can be reattached only at most 4 mm. in front of the insertion, and so on.

In the combined operation, i. e., with tenotomy of the internal muscle, one further advantage of the method may be pointed out. The patient still has the use of the external rectus muscle, which facilitates tenotomy of the internus, and after the tenotomy the exact degree of deviation still uncorrected is evident and can, to some extent, be modified by the amount of the tightening of the external sutures.

After withdrawal of the speculum the eye is again washed with boric lotion and bandaged. The writer has not found it necessary to bandage both eyes, even for a limited period.

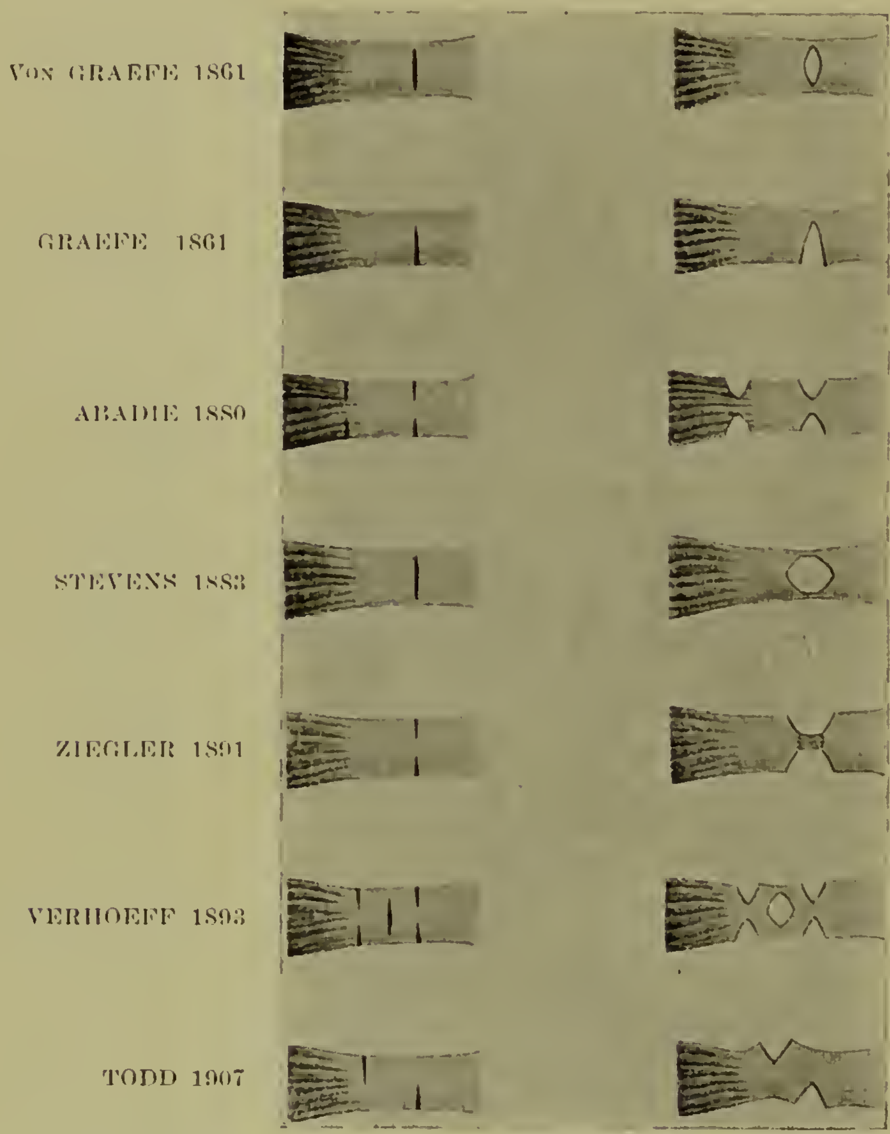
Daily washing of the conjunctival sac with boric lotion is prescribed and the stitches removed in the simple advancement operation on the twenty-first day, the eye being bandaged for that period. In the combined operation the inner conjunctival suture is removed on the fourth day, the external sutures on the tenth day.

Tenotomania. An inordinate propensity to perform tenotomy, especially on the ocular muscles.

Tenotomy. The cutting of a tendon, as for strabismus. It is generally divided into *complete*, *partial* and *graduated*. See **Muscles, Ocular.**

Tenotomy, Curb. A term applied to the ordinary operation of cutting an ocular muscle-tendon in squint and inserting it farther back on the globe.

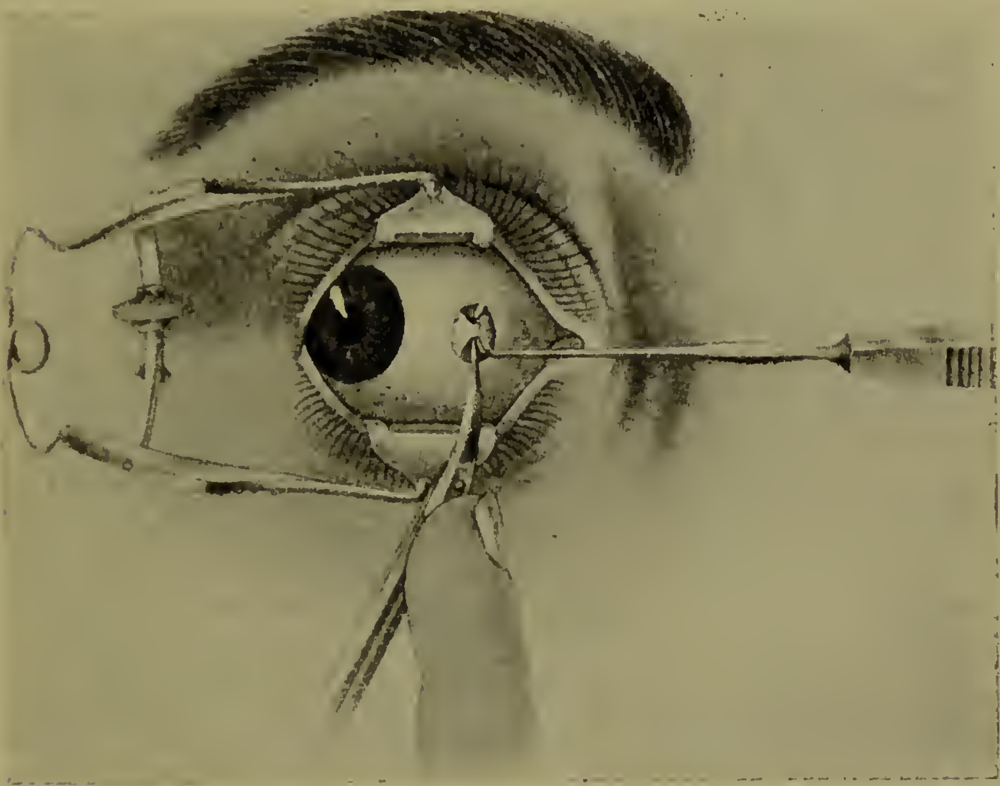
Tenotomy, Partial. INCOMPLETE TENOTOMY. Incision of one or more ocular tendons has been studied under the subsection *Operations* of **Muscles, Ocular.** In addition to the matter there published it may be said here that S. Lewis Ziegler (*Ophthalmology*, April, 1911), finding it difficult to rely on the accuracy of either the von Graefe or



Various Forms of Partial Tenotomy. (Ziegler.)

Maddox tests as ordinarily employed in heterophoric operations, has devised a simple *test-object as a substitute for the candle or small gas flame* in the von Graefe test, that will stand out with the greatest clearness when used with the red glass and displacing prism. This consists of a plain Greek cross cut out of blackened metal (1 mm. thick) and placed over a thin slip of dull ground porcelain (2 mm. thick), behind which is stationed a gas lamp or an electric light. The

cross is held in position by a blackened metal hood, which also serves to conceal the light and prevent any annoyance from dispersed rays.



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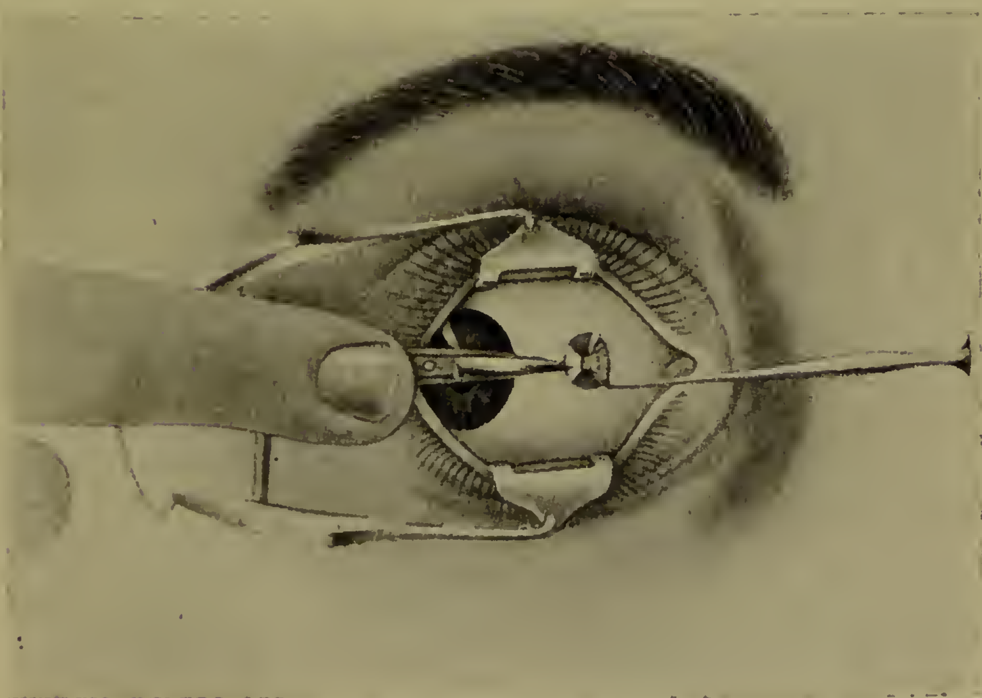


B

Ziegler's Operation for Partial Tenotomy.

The size of the open cross most desirable for use at a distance of 6 meters is 60 mm. for the length of the arms, and 10 mm. for the width.

It is not desirable to have the illumination too strong as the edges of the arms will appear fuzzy, owing to the dispersion of light.

The lighted Greek cross having been put in position, the proper displacing prism is placed over the left eye, and the red glass over the right eye, as in the original von Graefe test. A displacing prism of P 8° base in, is generally used to measure the vertical error, and P 5° base up, to measure the horizontal error. If sufficiently displaced the contrasting red and white crosses can be easily recognized by the patient and differentiated at every stage of the operation. Patients previously operated upon under the older tests have responded with greater accuracy to the newer test made during a subsequent operation. The author's satisfaction in using this test-object for operative cases has led to its adoption for all heterophoric work. A smaller Greek cross printed in black on cardboard is similarly employed as a near test-object instead of the von Graefe line and ball, the ball alone, or the single word object. The proportions of the smaller cross are relatively the same as the larger one, the arms being 3 mm. in length and 0.50 mm. in width. This test for heterophoria at the near point has also proved to be more reliable than other tests, for the same reasons that apply to the distance test.

The following advantages have been found to accrue from the use of this test in measuring muscular imbalance: 1. The Greek cross test-object is easily recognized by the patient, even under the partial blurring of vision which occurs during tenotomy. 2. The patient can accurately line up the vertical deviation by the horizontal arms of the cross and the horizontal deviation by the vertical arms of the cross. 3. The four arms of the cross attract the attention of the eye separately, causing complete dissociation of the two images and consequent relaxation of the muscles. Hence, the tendency to fuse is almost nil. 4. A series of examinations shows less variation than by other methods, which demonstrates the constancy, accuracy and reliability of this test.

Ziegler also pictures the various forms of partial tenotomy in use from the introduction of the operation.

Tension, Accommodative. The act of tension or contraction of the ciliary muscle; also that condition or degree of accommodation which goes along with a given degree of convergence of the ocular axes.

Tension, Intraocular. OCULAR TENSION. INTRAOCULAR PRESSURE. TENSION OF THE EYEBALL. The pressure of the fluids of the eye against the tunics. It is produced by the continual renewal of the fluids within the interior of the eye. Normal tension is indicated by the symbol Tn., and the signs T. + 1, T. + 2, T. — 1, T. — 2, etc., indicate degrees of increased or diminished resistance.

This subject has been discussed under various captions of this *Encyclopedia*; notably on p. 1227, Vol. II and p. 2262, Vol. III, and in the introduction to **Glaucoma**. See, also, **Tonometry**, p. 4629, Vol. VI, and **Sclera** headings.

Further consideration of the *relations of the general blood pressure to the intraocular tension* is given in the discussion of the physiology of the subject by the Ophthalmic Section of the Royal Society of Medicine. A report of this conference is published in the *Ophthalmic Review*, p. 122, April, 1913.

According to Ibershoff (*Journ., Ophthalm., Oto-laryng.*, Feb., 1913) every increase or decrease in blood pressure results in a corresponding temporary alteration in the ocular pressure. This temporary change is quickly compensated for by a reciprocal alteration in lymph excretion, so that the volume of the ocular contents remains fairly constant. The intraocular fluids are the result of an osmotic process through the ciliary processes. There are no lymphatics in the eye and the iris and vitreous have no secretory function.

Permanently increased tension is not due to high blood pressure directly, but may co-exist with it only in the absence of adequate compensation. Five cases are reported in proof of this contention by Ibershoff. High blood pressure in a person having a small cornea or a large lens predisposes to glaucoma. It requires but an agency to upset the balance of secretion and excretion. He thinks that sudden lowering of the ocular tension by opening the eyeball, subjects the eye to the danger of hemorrhage; consequently, blood pressure should be lowered first.

The writer believes that senile cataract is due to an osmotic imbalance, the vitreous and aqueous being either hypertonic or hypotonic to the lens. He thinks the presence of an increased amount of sugar in the ocular fluids in diabetes may explain the frequency of cataract in such subjects. In the presence of increased blood pressure the ocular fluids have a higher specific gravity and he thinks these fluids being hypertonic to the lenses causes it to shrink and become opaque. The author is of the opinion that further studies along this line will show that the regulation of blood pressure will prove a valuable method of non-operative treatment of glaucoma and cataract.

R. Lederer (*Archives of Ophthalm.*, Vol. XLIII, No. 1, 1915) by the use of a special manometer tested the *influence of active ocular movements on the tension of the globe*. He observed the eyes of a rabbit, a monkey, and a man and found that the graphic curve registered on a modified kymograph, showed a close correspondence between rise of tension and various phases of ocular motion. He thinks that

the negative results registered with the Schiötz tonometer are due to the fact that that instrument gives varying records according to the curvature of the part of the eye on which it is placed. The manometer alone is therefore better adapted for such an investigation. Lederer points out that when a muscle and its antagonist contract, they draw the eyeball back against the orbital tissues, and thereby raise its tension.

Guglianetti (*Archivio di Ottalm.*, 21st year, p. 382, 1914) conducted an investigation into the *influence of high altitude pressure on the intra-ocular tension.* The Schiötz tonometer was used, and observations were taken at (1) sea level, and (2) elevations of 3,000, and of over 4,500 metres. Dogs and rabbits were used, as well as human beings. In no case was any influence of the pressure of the high altitudes in evidence. Guglianetti draws attention to the fact that experiments have shown that high altitudes have no influence on general blood pressure. The fatigue factor was carefully excluded.

R. Kümmell (*Archives of Ophthalm.*, Vol. XLIII, No. 1, 1915) has drawn attention to the *increase of tension in eyes injured by burns*, or by the chemical action of strong acids or alkalies. The condition commences four or five days after the injury, lasts a week or more, and may require the use of myotics for its relief. The chamber is deeper than normal, and often irregularly so; with this sign is associated an agglutination of the tissues at the angle. Kümmell considers that the increase of tension and the deepening of the chamber are both due to the obstruction to outflow, caused by the closure of the irido-corneal angle; he suggests that the increased albumen content of the aqueous may be a contributory factor. He points out that a similar type of high tension attack is met with, whether the burn is due to the action of chemical reagents or to ordinary burns, such as those seen amongst slag-burners, provided only that the limbus is affected.

Hertel (*Arch. f. Ophth.*, Vol. 88, p. 197, 1914) has shown that the *intraocular pressure* can be much *influenced by alterations in the composition of the blood*, irrespective of fluctuations of the blood-pressure. He describes in detail his experiments on eighty rabbits into whose jugular or auricular veins he injected solutions of varying concentrations of crystallinic and colloidal substances, recording the intraocular tension with the tonometer of Schiötz and the blood-pressure. The substances used were chloride, sulphate, phosphate, bicarbonate, acetate, isovalerianate, and butyrate of sodium, grape sugar, urea, water, gelatine, albumin, yellow of egg, horse-serum, human-serum and the blood of rabbits. In general, the effect of all substances was analogous to that of chloride of sodium; the solutions of higher percentage diminished, those of lower percentage increased, the intra-ocular pressure.

The effect of these injections depended on the osmotic concentration of the solution, irrespective of the substances. The blood-pressure was not much influenced thereby, or very irregularly. The blood itself showed changes of concentration, while there was a diminution of the water content of the eye, proving that the infused solutions act directly on the eye. In the dead animal the infusion of a solution of sulphate of sodium of 10 per cent. and 0.45 per cent. increased the tension. The occurrence of edema in other parts of the body of the dead animal suggested that the vitality of the membranes which must be passed is of importance, and pointed to the endothelium of the vessels.

Lagrange (*Archives d'Ophtalm.*, June, 1914; reviewed by James, *Oph. Review*, p. 116, April, 1915) is of opinion that in order to *raise the tension of abnormally soft eyes* we ought to attack the ways of filtration from the eye, just as is the case in dealing with eyes which are permanently too hard, and he postulates that to raise the tension from the subnormal,. the means used should be simple, well regulated and free from dangers, and he proposes to effect this result by making artificially a more or less thick cuirass of fibrous tissue, devoid of vessels at the level of the filtration angle, under the conjunctiva, round the cornea, so that fluid trying to escape from the eye by the usual way through the spaces of Fontana and the canal of Schlemm to the anterior ciliary veins, shall find the paths of exit more or less blocked.

He eventually settled on an operation, suggested to him by Valude, for which he proposed the name of felting [blocking or padding] *(feutrage)* the eye, which is performed as follows: a circular incision is made in the conjunctiva around the cornea, and the conjunctiva is dissected up. The gavlano-cautery is then applied to the sclerotic all the way around, but not deeply, in the region of the ciliary body, the intercalary space, hoping to excite by these means in the cauterized region a fibrous ring, dense, abundant, and relatively impermeable. This serves to seal up those filtration ways in the anterior segment of the eyeball, and he couples with this subconjunctival injections of saline behind the equator of the globe, thereby hoping to close to some extent by the formation of adhesions the filtration ways at the back of the eye.

The reviewer adds that the theory of this procedure seems brilliant; the practice not so brilliant. Soft eyes are notoriously eyes to avoid meddling with if possible. Granted that Lagrange's method presents no great difficulties in performance, requires no marked manual dexterity; granted that it may be free from danger, yet it appears that from his own cases it is not easy to regulate the amount of scarring

produced, and the amount of rise in tension. Altogether we are inclined to look upon the whole matter as "playing with fire."

Walter R. Parker (*Journ. Am. Med. Assocn.*, Oct. 7, 1916) after a series of observations and experiments (in which he wisely included monkeys among his animals) on the *relation of choked disc to intraocular tension*, concludes that: 1. Choked disc can be produced in the dog and monkey by artificially increasing the intracranial pressure. The most satisfactory results are obtained by the use of sponge tents. 2. When the intracranial pressure is increased by artificial tumors placed in the occipito-parietal region, one element in determining which disc will be affected first is the tension of the eyeball. 3. When the intracranial pressure is increased by artificial tumors placed in the occipito-parietal region, the nerve in the eye of least tension is the first to show the choked disc. 4. When the intracranial pressure is increased by artificial tumors placed in the occipito-parietal region, there is no direct relation between the location of the tumors and the eye first affected.

Tension symbols. See p. 1264, Vol. II of this *Encyclopedia*.

Tensor choroideæ. The name given by Brücke to those radial fibres of the ciliary muscle that are concerned in the focusing of the eye. See **Accommodation.**

Tensor tarsi. A small, thin muscle, situated at the inner side of the orbit, behind the tendo oculi. It arises from the crest and adjacent part of the orbital surface of the lachrymal bone, and, passing across the lachrymal sac, divides into two slips, which cover the canaliculi and are inserted into the tarsi near the lachrymal puncta. See, also, p. 361, Vol. I of this *Encyclopedia*.

Tephrion. See **Cythrion.**

Tephrion, The. A common collyrium for lippitudo in Greco-Roman times. It was composed of starch, tragacanth, acacia juice, gum, poppy tears, washed ceruss, washed litharge, and rainwater. For the exact proportions in which these ingredients were combined, see **Celsus.**—(T. H. S.)

Tepor. Gentle heat.

Teratism. A monstrosity; any anomaly of formation. A fetal monstrosity. See **Congenital anomalies.**

Teratoid tumor. Teratoma. See **Congenital anomalies of the eye,** p. 2957, Vol. IV of this *Encyclopedia*.

Teratology. The study of malformations, monstrosities, or abnormal growths, animal or vegetable.

Teratoma. A tumor containing fetal remains congenitally derived, such as teeth, hair, etc. It is supposed to be due to the inclusion of

an aborted fetus within one which develops normally. See **Teratoid tumor.**

Ter in die. Latin for *thrice in a day,* generally written t. i. d.

Terminalia bellerica. A large East Indian tree. The kernels of the fruit, which yield an oil used as a hair-tonic, are edible, though narcotic in large quantities; mixed with honey, they are used in ophthalmia.

Terminal ray. The limiting ray of a pencil of rays.

Terminol. A proprietary remedy, a 5 per cent. copper citrate ointment; used in trachoma and other eye diseases.

Grunert (*Amer. Jour. Ophthal.,* Sept., 1911) has discarded cuprocitrate, introduced several years ago by von Arlt, on account of its irritating effects, in his opinion due to its high percentage of glycerin and the imperfect and coarse distribution of the salt. He now prefers terminol in trachoma and follicular conjunctivitis. After applying it twice a day for several weeks the follicular and papillary swelling subsides, leaving a slight diffuse redness and swelling of the conjunctiva, which now requires a milder astringent, as zinc, suprarenin drops. For mechanical treatment, Grunert devised a more liquid salve, "Terminol-crême." The cocainized conjunctiva is energetically rubbed with cotton dipped into this salve.

Ternary. (a) Proceeding by threes; consisting of three. (b) A group of three.

Terrain. (F.) Locality; territory.

Terra lemnia. White clay. See **Argilla.**

Terra sigillata. White clay. See **Argilla.**

Terra turica. White clay. See **Argilla.**

Terrestrial telescope. A telescope giving an uninverted image of the object viewed.

Terrole. A proprietary mineral-oil preparation for use in eye, ear, nose, and throat diseases.

Tertiary positions of the eyes. These result from movements in which the lines of vision are convergent and are at the same time directed downward and upward.

Tessellated fundus. An ophthalmoscopic picture of a normal fundus which shows a plexus of bright lines, the vessels resting on a dark background.

Test, Boveri. This color-reaction *test of the spinal fluid* is discussed by Bardisian (*Journ. Am. Med. Assocn.,* May 24, 1919), who tabulates the findings applied to 50 young children. They were constantly positive with the 13 with meningitis; in 2 of the 5 with hydrocephalus; constantly negative in the 12 with gastro-intestinal or lung lesions;

positive in 1 with tetanus, but negative in the 9 others with acute infectious diseases. and constantly negative in the 9 with nephritis, inherited syphilis or other disease. The test is applied with a test-tube containing 1 c.c. of the cerebrospinal fluid. The tube is held slanting, and 1 c.c. of 0.1 per thousand solution of potassium permanganate is poured down the wall of the tube. The tube is then straightened and the zone of contact watched. With normal fluid there is no change of tint, but with pathologic fluid the zone of contact turns yellow. On giving the tube a few gentle shakes to mix the fluids, the yellow tint may spread throughout. If the reaction is strong, it occurs in less than two minutes; a medium reaction takes three or four minutes, and after the fifth or sixth minute the reaction has no significance. The response is more sensitive than the Nonne, Apelt, and Noguchi reactions. The most intense reactions were observed in cases of meningitis. Bardisian describes four cases in detail in which the diagnosis of meningitis seemed certain, but the negative Boveri turned the scale to exclude meningitis; its findings were confirmed by the course of the diseases.

Test cards. See **Test charts,** and **Test-types.**

Test charts. Test cards. Test types. Test letters. Test objects. Optotypes. This subject has already been considered with numerous illustrations, under various **Chart** captions, beginning with p. 2007, Vol. III; also under **Examination of the eye,** p. 4641, Vol. V, *et seq.,* to which the reader is referred. (See, also, **Test-types**, *infra.*) Some additional remarks and cuts (in alphabetical order) are here given.

Standard test cards. The following report (which should be carefully read by every ophthalmologist) was presented to the Section on Ophthalmology, A. M. A., June 14th, 1918. The work of the committee (*Am. Journ. of Ophthalm.*, Feby., 1919) was especially directed to *figures designed for testing those not familiar with our alphabet.* Essentially the same plan of comparative testing of the different figures was used. Over 180 different figures were tested, the collection and preparation of these figures having been done by Dr. Ewing.

The committee selected the accompanying characters from among the various designs which heretofore have been submitted by authors on this subject.

Small variations in the size of letters would be subject to criticism because of incongruity to the eye, but small variations in the size of the figures here considered are not noticeable; provided the figures are well proportioned and are arranged to line up evenly with one another. The choice is based on the following principles: (1) The lines of which the chief framework of the character is constructed should each

subtend the angle of one minute. (2) The main body of the character should conform to the five minute visual angle. (3) Slight unobtrusive variations may be made in the lengths of the lines of the characters beyond the five minute angle, in order to insure legibility; as it is practically impossible to construct pictures of ordinary well known objects in the five minute space with lines of one minute thickness. (4) Masses of black are undesirable. (5) Finer lines than subtend the angle of one minute are to be avoided in the body of the character. (6) As any one character cannot be depended on for a visual measurement, the smaller characters for distances less than 20 meters should be arranged in rows of three or four each. The reading of the row is considered by the committee to be the equivalent of V = 1.

The interval may be in any ratio, but the geometric ratios of Green are suggested as being the most advisable.

Figures Suggested for Testing Illiterates, Recognized at 5 Meters by V = 1.

The characters suggested by the committee are those indicated in the accompanying diagram. They consist of the ring, square, star, pitcher, cross, horseshoe, flag, fork, and chair. They should be printed in black on a creamy white background and the paper or board should be of sufficient hardness to prevent the type sinking into it.

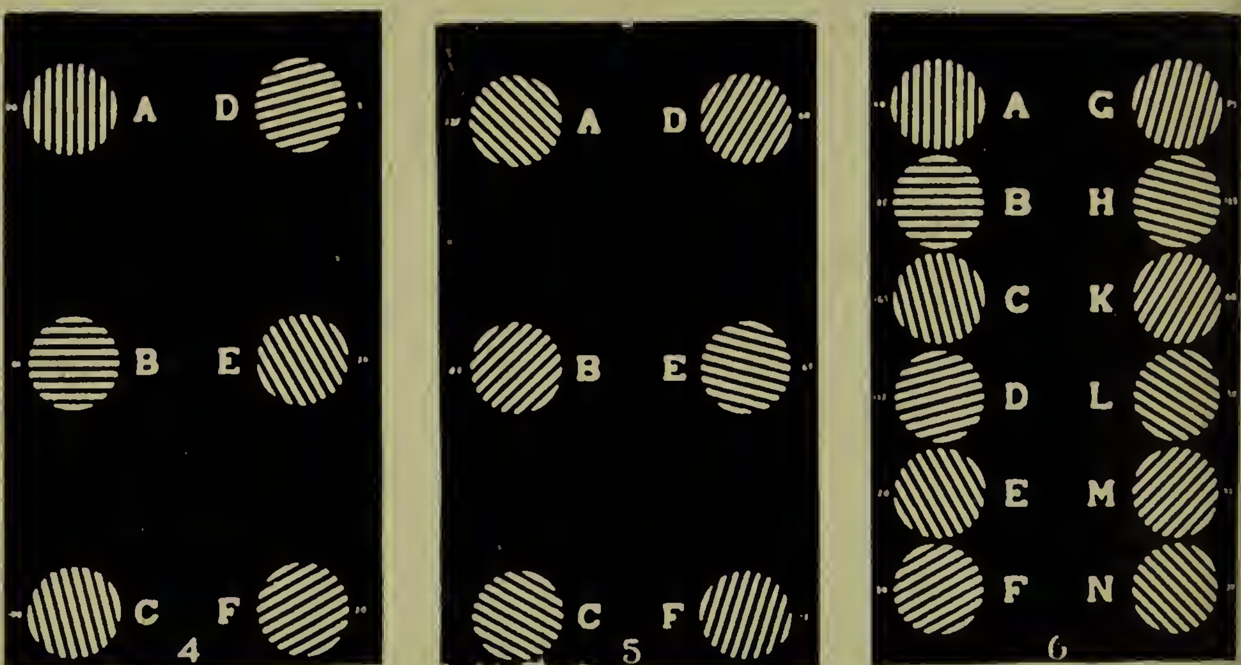
There is a distinct advantage in having a relatively small number of these characters repeated on successive lines of the chart. Because in this way it can be known from the larger lines whether the person tested understands, and responds properly to the test.

The characters suggested by the committee are for subjective tests to meet the requirements of useful vision. They conform so well to the letter tests that the two may be readily interchanged.

In addition to the characters here presented, the several more accurate tests, ordinarily designated as "one minute" tests in contradistinction to the five minute tests, have been considered.

These are the Snellen "E," the Landolt "Broken ring," the Jackson "Incomplete square," the "E" and the incomplete parallelogram forms of Pergens, also the several varying one to three minute tests of Pergens, the "Cross-point" and "Line-point" tests of Wolffberg, and the Central broken line test of Ewing. Taken singly each of these tests is practically the equivalent of the others. They are excellent for employment in the final checking up test, when there is any question of a fine degree of visual acuity involved; and for the repeated testing of persons with greatly reduced vision.

The trouble with each of them is that the location of the "one minute" test must be indicated either by pointing to it, or by naming the position in which it is to be placed. This, including the instruction



Astigmatic Test Cards.

with regard to the test which must be given the patient, requires a greater amount of time than the simple naming of a test object. However, the committee recognizes that these "one minute" tests are necessary for the exact comparison of the vision of the same eye at different times, or of one eye with that of the other, or for comparing the exact vision of different individuals; and advises that every ophthalmologist have one or more of them on hand in case special accuracy is demanded.

For obtaining an idea of the vision of very young children the committee indorses the suggestion of Worth, that balls of various sizes be employed. However, in place of the ivory which is used by Worth, a noiseless material as paper, yarn, cork, or rubber painted white or

black to contrast with the background would be superior for the construction of the balls.

Semaphores are special tests for railroad and signal service employment, although they may be considered tests for the illiterate. The committee recommends those designed by Charles H. Williams and by N. M. Black.

Astigmatic test objects. See, also, **Astigmatism.**

Axenfeld's test-type indicator is intended for children and other illiterates. The person under examination must indicate the direction in which the circle is broken. See the cut.

Axenfeld's Broken Circle Test Type Indicator for Children.

Bjerrum's test-types. See p. 1004, Vol. II of this *Encyclopedia*.

Boettcher's test-types. See p. 1241, Vol. II of this *Encyclopedia*.

Burchardt's test-types. These form a series of groups of circles, which are reproduced by photographs in diminishing sizes until they become dots of extreme minuteness.

Cabinet test-types. Most dealers advertize one or more of these. Dixey's box of test-types contains eighteen cards of types, which are displayed consecutively as shown in the illustration. The large number of cards allows the employment of two or three rows of each size of type. One row only is exposed at a time. The change of cards is effected by a cord which runs on pulleys, and is operated by the sur-

geon from a position at the proper distance from the types. The cards are illuminated by two electric finger lamps and suitably shaped reflector. Any types can be inserted, and they can be adapted to any usual distance.

Dixey's Box of Test Types.

In *Covell's test-type cabinet,* the types are manipulated by a cord, which is carried to the hand of the operator, and any single line of types can be brought into view. Besides the regular sizes of types,

Covell's Test Type Cabinet.

half of an astigmatic dial and a single dot can be brought into view. The cabinet is electrically illuminated in such a manner that the types can be brought into view either transparent or by reflected light.

Cohn's test-types. See p. 2317, Vol. IV of this *Encyclopedia.*

Color tests. See Color sense; as well as 5086, Vol. VII of this *Encyclopedia.*

Diaphragm test. See p. 3954, Vol. V of this *Encyclopedia.*

Duane's test-objects for determining the near point and the range of accommodation. This observer (*Ophthalmic Record*, July, 1909) says that to be efficient the test-object must be very fine and sharp. There must be very little white about it, otherwise the sight becomes dazzled quickly. For the same reason, there also must be no shiny surface about the object. The background on which it is placed should be dead black. Velvet, being almost the only surface which gives a deep black absolutely free from shine, is the ideal background. In

Test-Disc (Duane).

For the sake of distinctness, the fine black line bisecting the white parallelogram in the centre of the disc is made about twice as thick in the cut as it is in reality. The dimensions of the white parallelogram are 3x1.25 mm., those of the black line are 3x0.2 mm.

the test-object itself, to secure the best results, there must be a definite relation between the areas of the black and white portions. Duane accordingly chose a disc, 38 mm. in diameter and covered with velvet, which is set in a ring like that in which the glasses of the trial case are mounted. The ring and its handle are blackened. On the center of the disc is glued a white card 3 mm. by 1.25 mm., which is exactly bisected by an engraved black line 3 mm. long and 0.2 mm. thick. This line must be very sharp, even, and free from any slight irregularities. To determine this, it should be examined with a strong magnifying glass, and any sample, even slightly defective, should be rejected.

The test is employed in conjunction with a Prince's rule, which should have a dull-dark surface instead of being polished, as usual.

The card is brought up until the engraved line blurs, then withdrawn till it is clear, then carried back and forth once or twice, until we ascertain the precise point at which blurring just begins. This will be the near point. The corresponding accommodation in D. is taken off from the rule. Usually several tests are required. Of course, to get at the true finding, it is necessary that the refraction should be accurately and fully corrected. In the case of presbyopia a convex glass of 1 or 2 D. must be added to the distance-correction, and the near point determined with this addition. From the corresponding value, read off from the scale, must be subtracted the value of the glass we have added.

The test should be made by daylight. The patient with one eye covered is placed with his back to the window, in such a way that a diffuse but not a dazzling light falls on the object. Care should be taken that there are no dazzling lights in front of or alongside the test-object. In looking steadily at the latter, the eye readily tires. If it does so, a moment's rest should be allowed.

It is particularly important that the patient should be told precisely what he is to see and that he should be urged to concentrate his gaze upon the test line, so as to accommodate with all his might. It is important also that measurements should always be made from the same point. Duane prefers the measurement from the anterior focus of the eye (or from a point 13 mm. in front of the cornea).

If the test-line is held alternately parallel and at right angles to the axis of the patient's astigmatism, some idea may be obtained whether the astigmatism is perfectly corrected or not. If not, his near point for one position of the line should be slightly different from the near point for the other.

The writer also employs the test-line as a means of exercising the accommodation. In neurasthenics and others with subnormal accommodation, systematic practice in approximating the line until the nearest possible point of distinct vision has been reached, has caused progressive approximation of the near point and an improvement in asthenopic symptoms. Such exercise should be done several times a day.

Evans' optotypes for illiterates. John N. Evans (*Am. Journ. Ophthalm.*, p. 425, 1918) believes that the defects in the optotypes for young children and illiterates lie chiefly in the selection of characters (1) made in silhouette, line, shading and combination of these. 2. The names of which may easily be confused. 3. Employing a multiplicity of characters. 4. Which are markedly inaccurate as a measure of visual acuity. 5. Representing objects unfamiliar to the young child.

One factor which seems to have been neglected by many authors is the one of the child's physical condition. The charts are stated to be arranged for children and illiterates but it will be noted that they often present figures far beyond the child's comprehension. "Surely," he says, "we need the help of what little understanding the child has. Illiterates may be either mentally deficient or of normal adult mind, and the chart if constructed to reach the young child, can be followed by them, but not the reverse. With this in mind it seems fair to allow 50 per cent. to favor the child's mentality and the other half to gain the visual acuity.

"From a study of the statistics we find that the average child in the public schools of Greater New York does not know his letters in a dependable way until he can read, nearly the age of seven and a half, and though he may know his numbers slightly under this age, at six and a half years, he is likely to give unsatisfactory answers at the time of testng. In New York City the child enters kindergarten at the age of five, and elementary school at the age of six, so that these are the ones we need most to reach when the relatively heavy work takes its first toll."

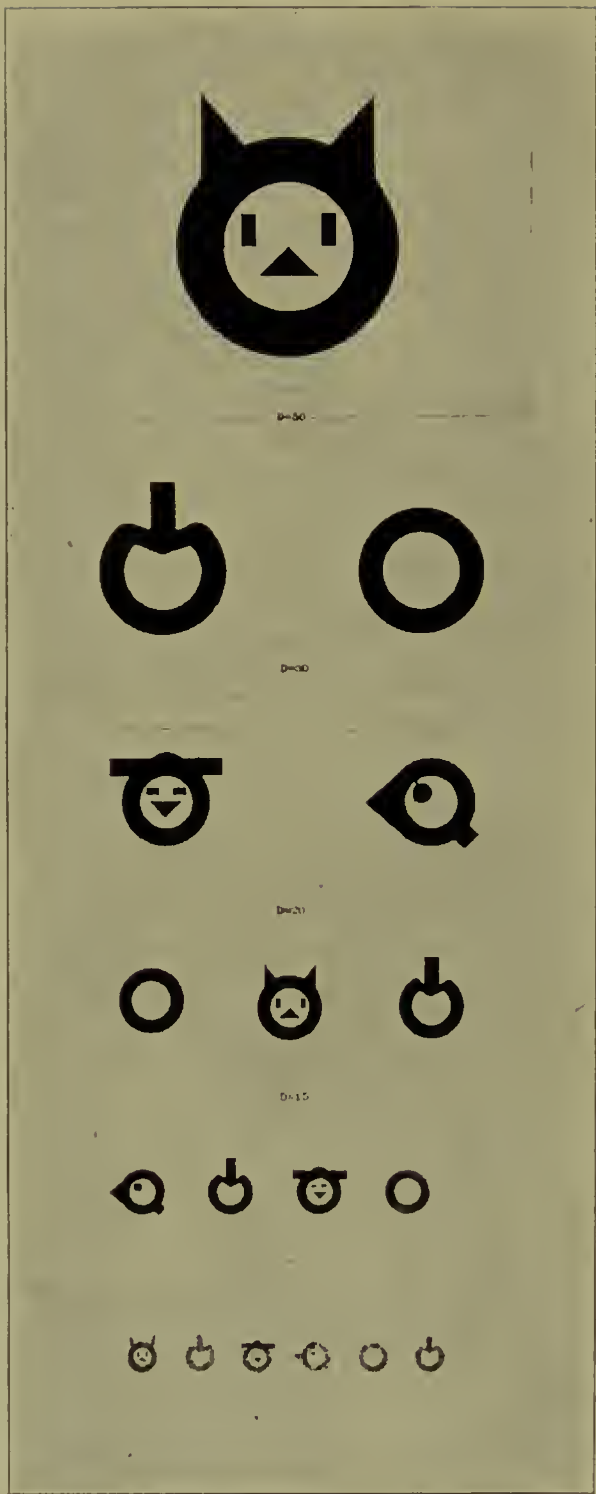
In the construction of characters for a chart certain principles are, Evans thinks, to be followed: 1. The characters are to conform as nearly as possible to the international standard, particularly in structural and visual value. 2. A circle, or ring, is to be used to form the body-structure on which the characters are built. 3. One-minute projections or interruptions of the body are to measure the capacity to perceive and recognize the individual characters. 4. There are to be few characters, as the child's vocabulary and concentrating ability are not to be overtaxed. 5. The characters are to be familiar to a child three or four years old.

In going over many characters used in kindergarten work, and in studying drawings made by small children, particular note was made of those which attracted the young child most and which he reproduced most successfully. After trying many of these it was found impossible to construct test characters from most of them, using a one-minute line and maintaining the five-minute size object. When finished most of them were so out of proportion as to be hard to recognize, or they formed undesirable black masses.

Those finally employed were:

1. The circle. This is simply the body on which the others are built. It subtends an angle of five minutes, the rim is of one-minute width.

2. The cat's head. The circle forms the body of the character and each ear represents a one-minute mass. The features were made small



Optotypes for Young Children (Evans).

so that the lower figures would not appear gray at six meters distance.

3. The man's head, built on the same circle, is distinguished from the cat and other characters, merely by recognizing that the projections are at the sides, thus forming a hat-brim. The crown is formed by an arc of short radius. The brim is formed by one-minute masses.

4. The apple is recognized by its stem which projects one minute above the rim of the circle and is the same in width.

5. The bird's head is formed on the circle by adding a one-minute mass for a bill and another for a neck. The latter, as well as the eccentrically placed eye, seem necessary to make the picture complete to the child.

Much develops in the use of the chart which is of interest to the psychologist.

There are many names by which the other characters are called:

Fridenberg's Stigmometric Test Types. Modified Snellen for Distance Examination.

Cat, fox, tiger, etc., man, monkey, pumpkin, etc., apple, cherry, plum, etc., bird, chicken, bird's eye, etc., circle, hoop, wheel, ring, etc.

Some of the advantages, Evans believes, of this test-chart are: 1. The chart has given good results with children as young as three years. 2. It can be used with ease in dispensary and office work. 3. It is not necessary to describe or point to locate the one-minute section, naming the character is proof that it is seen. 4. It requires only simple direct answers. 5. The names of characters are not easily confused with each other. 6. There are many names for each character, allowing the child to answer quickly and not to overtax its small store of names. 7. The

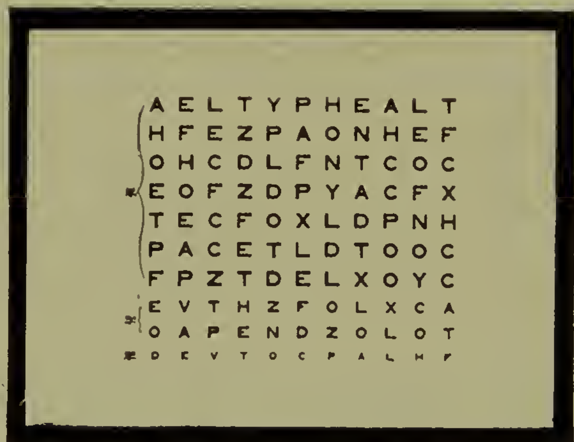
figures are such as have been learned in the child's own experience and represent very familiar objects, as he himself draws them. 8. It is a very satisfactory test for any illiterate. 9. It may be used with mirrors. 10. It supplies a practical "one-minute" test.

Fridenberg's stigmometric test-objects consist of a series of graduated round or square dots. They may be used for the distances and be counted at various *reading distances.* See the illustrations; as well as p. 4641, Vol. VI of this *Encyclopedia.*

Fridenberg stigmometric test type. A series of dots of definite and graduated size, in groups, to be *counted* at various reading distances as a test of vision and accommodation in illiterates.

Green's test-types. Types of different sizes forming an arithmetical series, the simplest form of Roman letters being used instead of the ordinary block letters. For testing the vision, the number of the smallest size of letters on the test-card should be less than the number of feet in the available distance.

Grow's unlearnable test card is described on p. 4645, Vol. VI; it is pictured in this text.



The Grow "Unlearnable" Vision Test Card.

Jaeger test-types. A series of letters and words of varying size, from No. 1, the equivalent of English brilliant, to No. 20, the equivalent of English 8-line. For the use of the illiterate, a cross (+) and an asterisk (*) of corresponding size were printed with each of the twenty varieties of type. These tests are used for testing the visual acuity for near.

Kuparoid test types. These are patented test types (see figure). They are intended to be mounted on glass by first soaking the chart in water, and then smoothing down until air bubbles are removed.

By mounting this type on a window pane, the uniform natural illumination of daylight is secured, leaving the test letters in sharp relief. It forms an accessory for hospitals and schools. The letters are opaque and the chart is not affected by atmospherical changes. The letters are also arranged with complementary colors of red and green as a binocular vision test.

Hardy's test-objects for illiterates are also illustrated in this text.

Test-Types for Illiterates. (Hardy.)

Landolt's test types. These (see the figure) have already been described on p. 4643, Vol. VI.

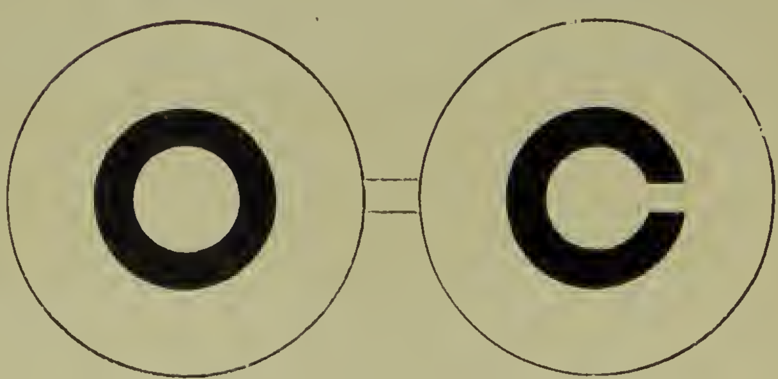
Monoyer's test-types are a series of lines based on the decimal system, in which the interval between each line is $\frac{1}{10}$ and the degrees progress from 0.1 to 1.0.

Moss-Blundell test type. This model is described in the *British Medical Journal*, July 4th, 1914. It is a movable type, a cut of which is shown. The type is mounted on a ribbon, which travels behind a white plate, with circular apertures. The appliance measures 10 in. by 4 in. by 1 in., so that it can be conveniently carried in a hand-bag.

Playing card test objects for illiterates are depicted in this text.

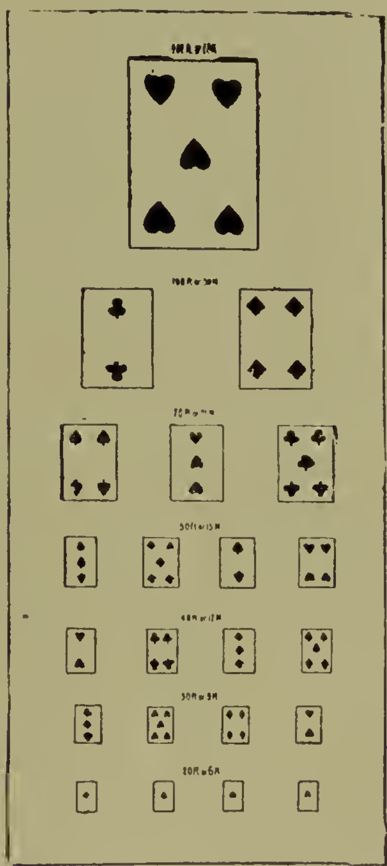
Pray's test letters. See p. 2012, Vol. III of this *Encyclopedia*.

Kuparoid Test Chart.



Landolt's Test Types.

Moss-Blundell Movable Test-Type.



Playing Cards Test Types for Illiterates.

Presas' Groups of Squares for Testing Visual Acuity.

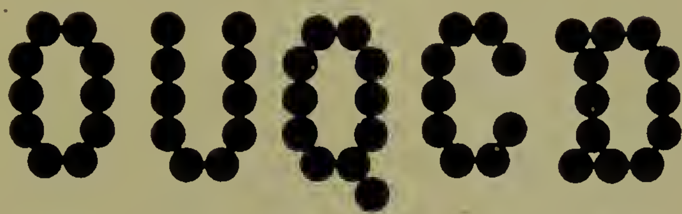
Skeel's test type holder. In this device the cards are held in spring clips which are themselves pivoted to the base-board, allowing the cards to turn like the pages of a book, exposing any one card to view. Any size or form of card may be used.

Skeel's Test Type Holder.

Skeel's Test Type Holder, with illumination.

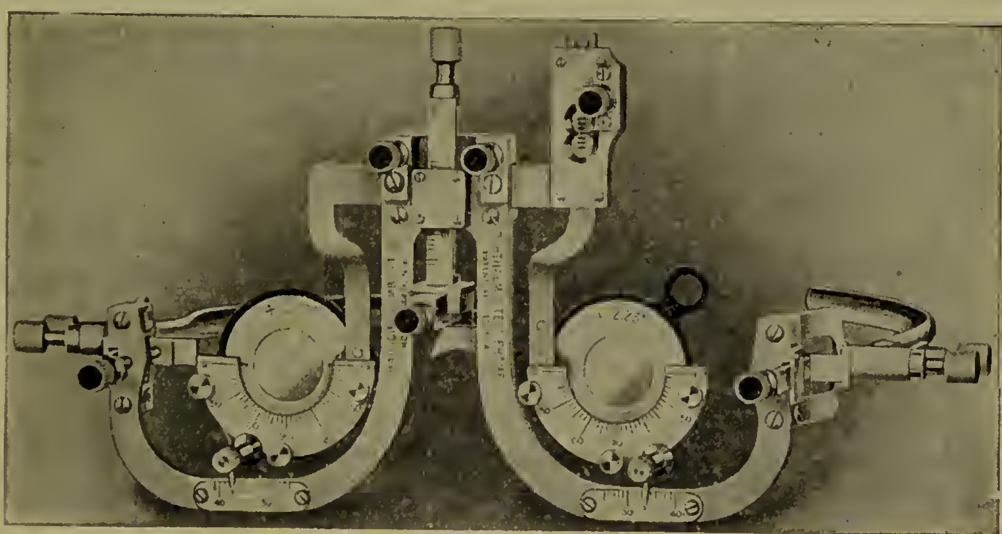
Wallace's test-types. Instead of the five-minute basis upon which the ordinary Snellen types are constructed Wallace arranged his on a four-minute basis.

Wolffberg's test types are described on p. 4642, Vol. IV. Here is depicted a modification of his original dots.



Wolffberg's Modification of Test Type, to be Read at 9 Meters, or 30 Feet.

Test, Chromatic aberration. See p. 2193, Vol. III of this *Encyclopedia.*
Test drum. See p. 4084, Vol. VI of this *Encyclopedia.*
Tester, Lens. See **Lens measurer,** p. 7410, Vol. X of this *Encyclopedia.*
Test, Excursion. See p. 4787, Vol. VI of this *Encyclopedia.*
Test frames. Trial frames. See **Frame, Trial,** p. 4732, Vol. VI, and p. 5284, Vol. VII of this *Encyclopedia.* In addition to the test frames there described a few more of these necessary devices are shown here, and in alphabetical order.



Ophthalmic Test Frame. (Bausch and Lomb.)

Bausch and Lomb's ophthalmic test frame. The makers describe this elaborate device (see the illustrations) as follows: A represents an independent frame, to which the temples are attached; B_1 and B_2 are the test lens holders proper, which are fitted with rack and pinion movement so that each test lens holder may be moved separately in a lateral direction; C is a rack and pinion arrangement by means of which one of the test lens holders may be moved in a vertical direction; D is a screw adjusting device for raising or lowering the entire frame; E is a similar adjusting device for bringing the frame nearer to, or

farther away from, the patient's eyes; F is a saddle piece hinged to rest firmly on the bridge of the patient's nose and adjust itself automatically to any shape of the nose; G_1 and G_2 are adjustable sighting devices by means of which the apex of the cornea may be sighted and its distance measured from the vertex of the curved surface of the test lens next to the eye; H_1 and H_2 are conical clamping arrangements serving the purpose of rigidly securing the position of the temples.

The temples themselves are hinged to this clamping device, allowing for abnormally large heads as well as extremely small forms of either normal or abnormal shape; I_1 and I_2 are adjusting screws for tightening the temples. The shape of the temples is such that they may easily

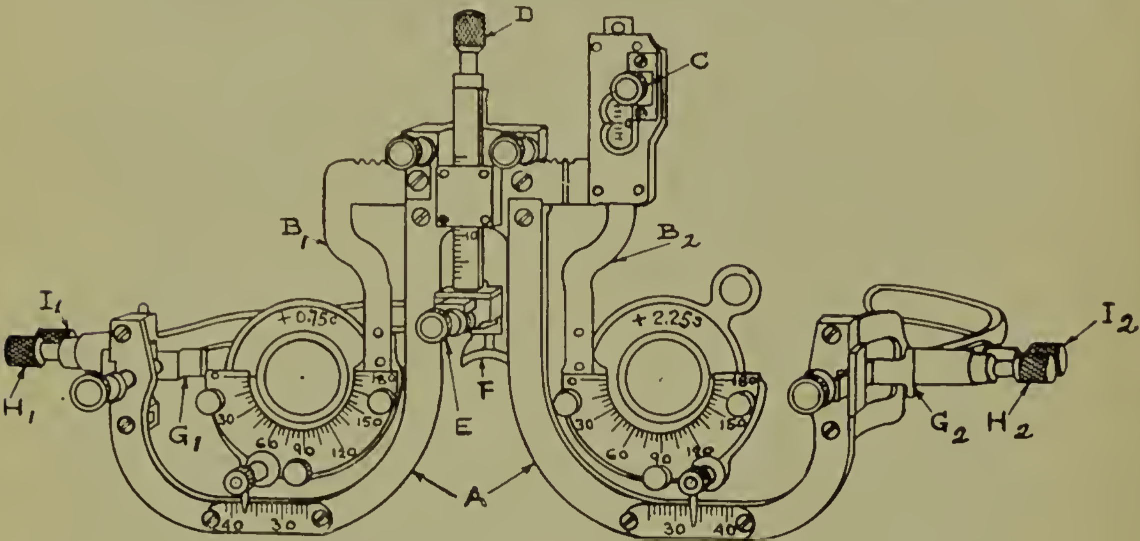


Diagram of Ophthalmic Test Frame, Indicating Different Parts.

be slipped on the patient's head. When tightening the temple screws, I_1 and I_2, pressure is brought to bear on the back of the head, and so the entire test frame is drawn toward the face of the patient, thus securing a firm fitting without undue pressure.

The test lens holders are each provided with four pockets, to take test lenses. The pocket nearest the patient's eye is intended for the spherical lenses, the second pocket takes the cylinder and the third and fourth pockets will accommodate a prism and additional lens or other accessory. At the bottom of the pocket for the cylinders is stationed a small wheel, milled at the outer edge, on which the metal mount of the cylinder rests. The axis of the wheel projects in front of the lens holder and terminates in a small milled head for conveniently rotating the small wheel, the milling of which engages the milling on the edge of the cylinder mount and rotates the cylinder.

The front surface of the cylinder pocket is provided with a protractor scale, divided into intervals of 5°. The position of the axis of the cylinder is indicated by a black line across the metal mount extend-

ing to the edge of the lens. This line serves as an index, by means of which the position of the cylinder axis can be read on the protractor scale, and at the same time provides a means of checking the position of the cylinder in its mount.

If a prism is required, it may be placed in the third pocket where it may be rotated independently of the cylinder. The prism mount is transparent and carries a black line to indicate the base of the prism. Using this line as an index, the position of the prism is determined by reading through the transparent mount the same protractor scale that is used to determine the position of the cylinder axis.

Each lens holder is provided with a pointer which indicates on millimeter scales visible at the bottom of the frame, A, the distance of each pupil of the patient's eyes, separately, from the center of the bridge of the nose. The bridge adjustments are also provided with millimeter scales, on each of which the zero mark refers to the position of the vertex of the spherical test lens so that all measurements count from that point.

While this new test frame enables the operator to make precise measurements of all data required in refraction work, its manipulation is the simplest possible. No details of a prescription need be written during the examination. The powers of the lenses may be read from the lens mounts and the specifications for the frame from the scales on the test frame after the latter has been removed from the patient's face.

The instrument is made of a light metal alloy, silver-like in appearance and of great durability. For sanitary purposes a sterilized waxed pad may be placed within the nosepiece for each patient.

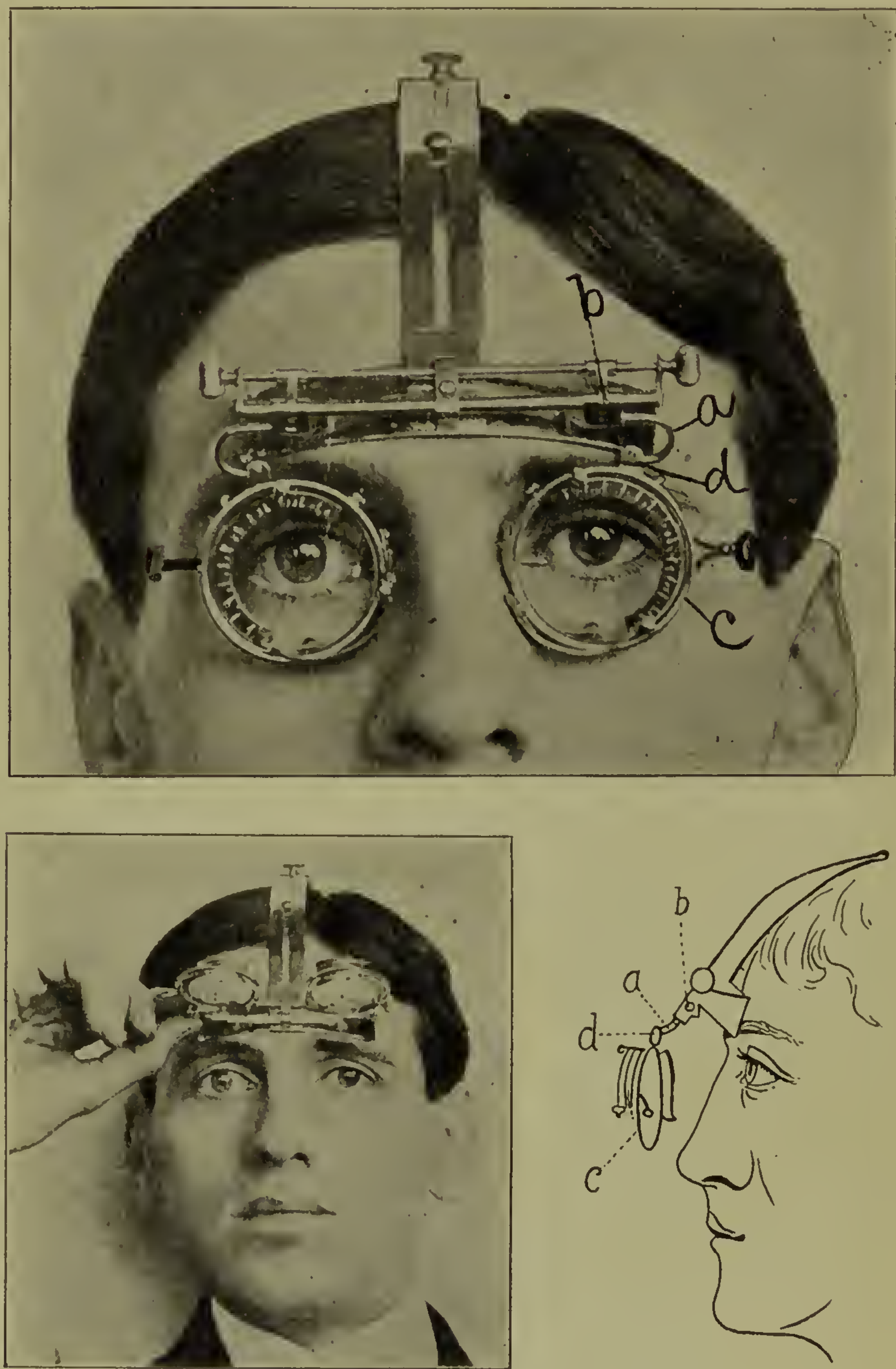
Genothalmic trial frame. Under this trade name has been marketed a light *trial frame with spring tilting temples* and a self-adjusting, hinged nose piece, the former closing automatically when the frame is removed from the face. They remain in place without the necessity of hooking them over the ears.

The Hogue-California trial frame. The trial frame here illustrated, while pictured in some instrument catalogs, has not hitherto been correctly described. Eaton describes it as the Hogue-California trial frame.

In the figure are shown the side mill-heads with very long shoulders, by which the two front cells on each side are revolved without interfering with the adjustment of the frame. The rear cross end of the spring metal head-band is now short and concave. The value of this frame can only be appreciated clinically.

The arm *a* is pivoted to *b* at the forehead bar, and at *d* to the cell *c*. This permits the lenses not only to be placed at varying distances from

the eyes, but also to be inclined forward to suit the downward gaze, and thus the plane of the lenses is adjusted perpendicularly to the line of vision.

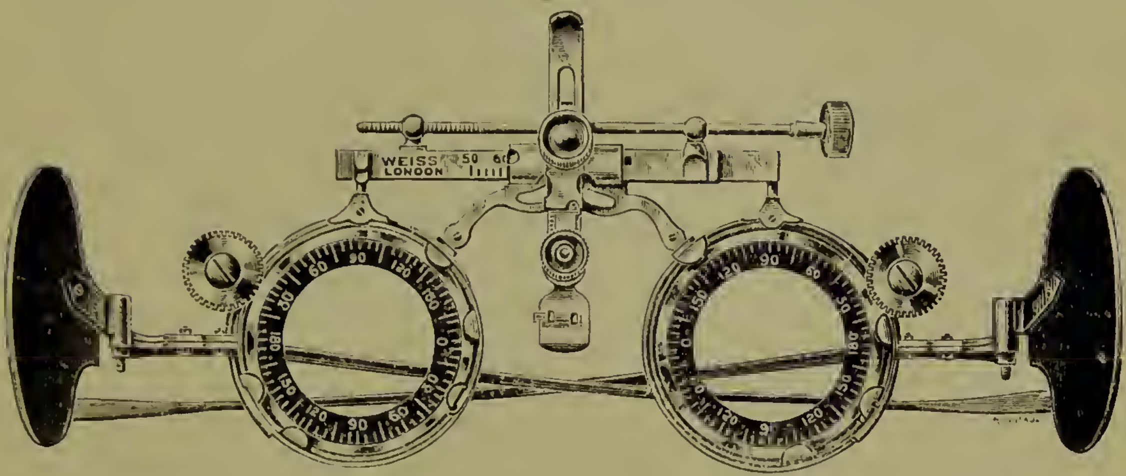


The Hogue-California Trial Frame. (Eaton.)

In skiascopy the frame is especially useful, since the lenses are easily adjusted, and by slightly leaning forward the surgeon can easily change the axis of the cylinder. Properly put on, the hair of women

patients is not deranged, nor the surgeon's patience, if he possesses an average amount.

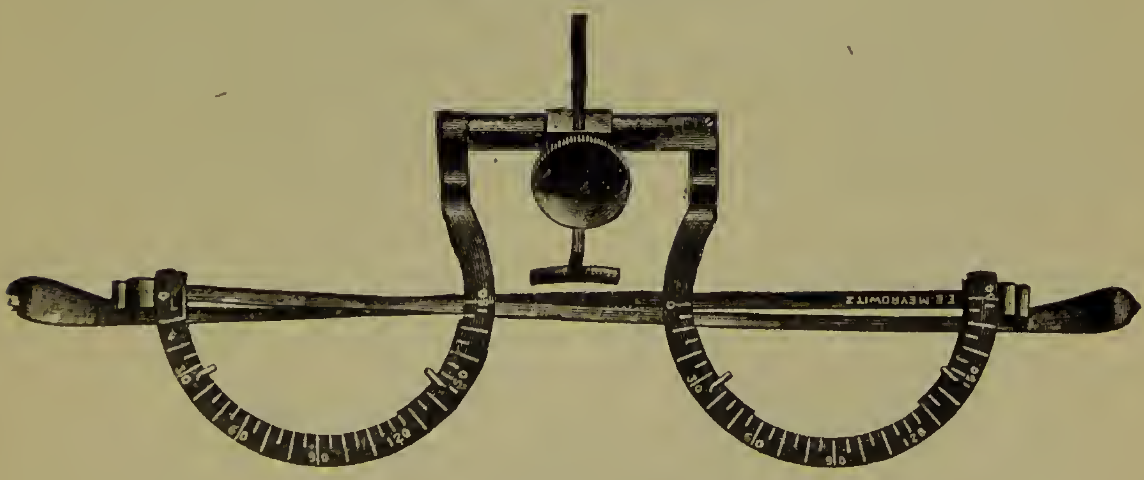
Landolt's double trial frame is intended for both spherical and cylindrical lenses, with adjustments for width of face, height of nose



Landolt's Double Trial Frame.

and for rotating lenses. It has shutters for obscuring vision of either eye, and a screw adjustment. See the figure.

Marlow's trial frame is intended for three pairs of lenses. The inter-pupillary distance, as well as the height, inset and outset of nose-piece, are controlled by one set screw. See the illustration.



Marlow's Trial Frame, for three pairs of lenses.

Walter Pyle (*Jour. Am. Med. Assocn.*, p. 966, Sept. 21, 1918) claims that ordinary trial frames and test lenses seldom conform to the modern standards of the skillful medical refractionist. In hospitals and dispensaries they are especially faulty, and often ludicrous. "It is most important that the trial frame shall be firmly and snugly placed on the sides of the nose and adjacent cheeks, in approxi-

mately the position in which the prospective spectacles or eye-glasses will be worn. In this respect all frames fixed to mechanical instruments, such as optometers, are at fault, often clumsy, and are signally deficient for accurate testing.

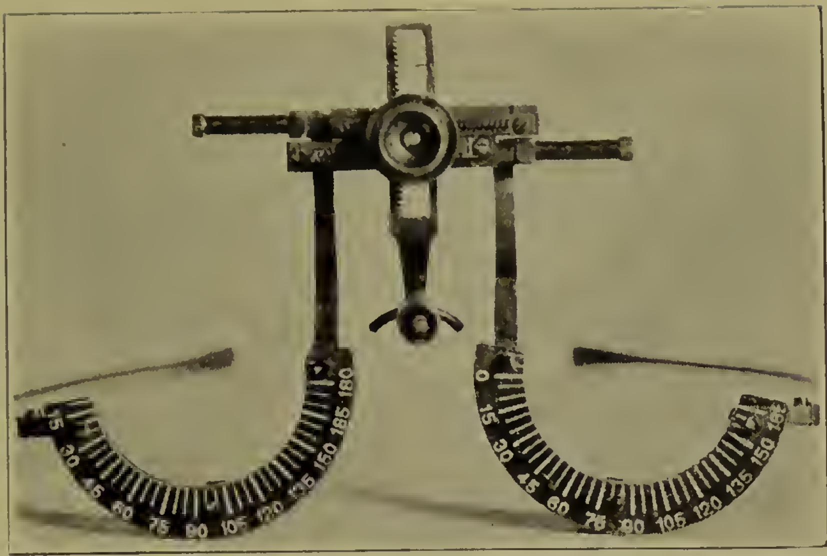
"The prime requisites for a trial frame are rigidity, lightness, proper position on the face, and ease of general adjustment and manipulation of the trial lenses. There is also a necessity for individual adjustment of the two sides, to permit perfect binocular centering.

"The test lenses, carefully centered, should be placed before the eyes, properly inclined, and just clearing the eyelashes. The bridge of the frame should not wound the skin or cause irritation or pain. Rotation of the cylindric lenses must be easy, silent and unnoticeable, to prevent even momentary diversion of the patient's attention. The frames should be grooved and slotted to allow rotation of the cylinders at least 180 degrees. The cells with the cylinders should have short handles, and the rotation should be effected by light contact on these handles with the tip of the first finger. It is impossible to practice noiseless and smooth rotation, when using cells without handles. The placing of the trial lenses in the spring clips is awkward, disconcerting to the patient and trying to the oculist. Only by the use of a properly grooved and slotted trial frame can the ideal examination of the refraction be made.

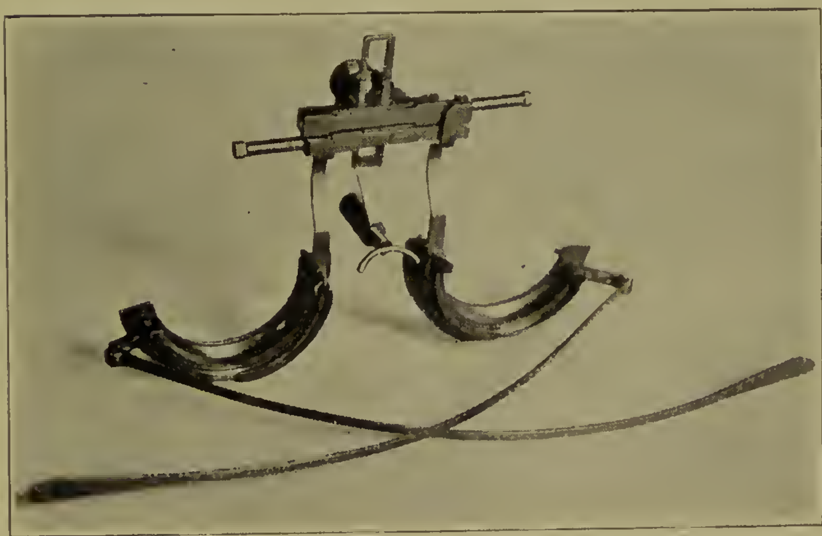
To meet these requirements the writer has invented the frame pictured in reference. It has a universal vertical and horizontal adjustment by rack and pinion movement, permitting adaptation for any peculiar facial conformation. This adjustment is placed in the center of the frame. The frame is grooved for two lenses. The front groove, for the cylinders, is slotted to allow rotation of the cells with handles. A third test lens may be placed in front of the frame resting on three small hooks. The bilateral adjustment is effected by two double screws operated on the upper outer side of the frame. The frame is placed on the face, quickly set by the universal adjustment, and supplemented when necessary by the movement of the independent double-screw adjustment, until the lenses are properly centered.

Broad shell coverings on the inner sides of the two cell holders permit the snug application of the frame to the sides of the nose and cheeks. The nose piece proper is used only to fix and maintain the proper position.

The graduated semicircles are enameled in dull black with distinct white lines and figures, allowing the maximal ease in reading the axes. The whole frame is finished dark and dull, to prevent annoying reflections.

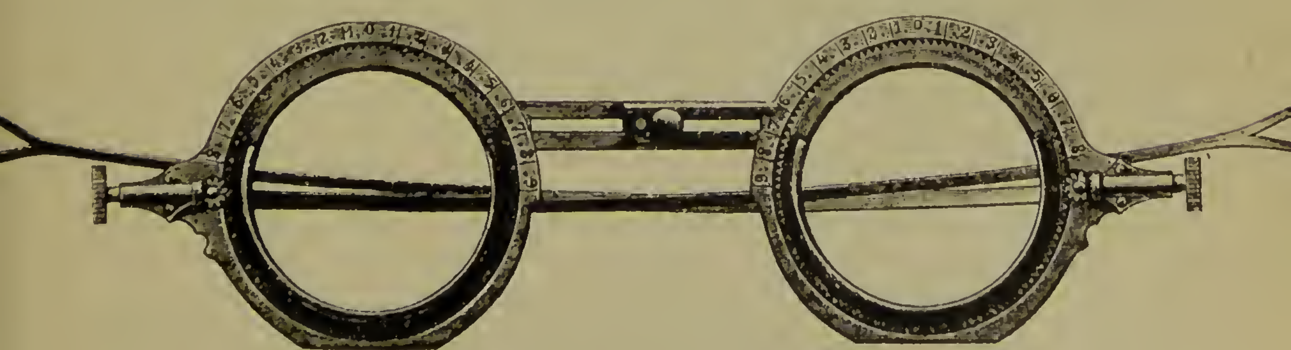


New Model of Trial Frame, Front View. (Pyle.)



New Model of Trial Frame, Back View. (Pyle.)

Reiner's trial frame. See the cut.

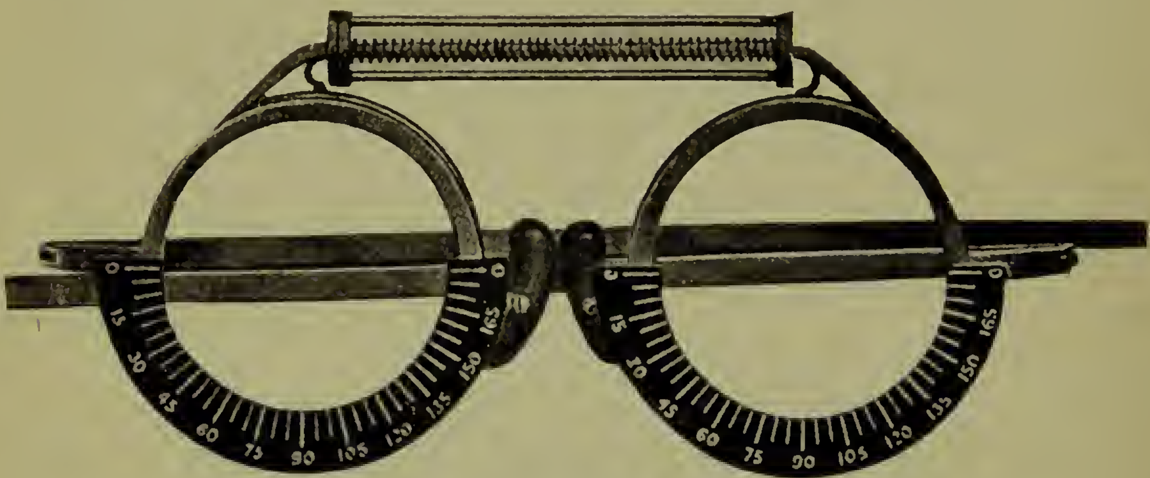


Trial Frames. (Reiner.)

The *Sutcliffe* (*Ophthalmoscope,* p. 446, Sept., 1915) *self-adjusting spring trial frame* is pictured in this text. The principal feature in this trial-frame consists of the substitution of a spring-bar, such as is commonly used in the ordinary rigid bar astigmatic frame eye-glasses, for the customary trial-frame adjustments for height, projection, and centering. The two right and left eye-cells clip on the nose by means of large smooth shell placquets.

The idea can be applied to any existing pattern of trial-frame, the various modifications of cells, shutters, sides, and goniometer scales remain unaltered according to the choice of the operator. The present model is shown as one pattern only.

The minor novel features of this particular pattern herewith shown are: 1. A graduation scale with the notation figures in bright relief against a dark background, so that usage and wear increase the contrast



The Sutcliffe Self-adjusting Spring Trial Frame.

instead of decreasing it. 2. A guiding-ring between the two front cell-slots, so as to allow of the easy insertion of trial-lenses in the dark room. This ring, however, if not required, can easily be cut away across its horizontal axis. 3. Broad, flat, extra short, straight sides or temples. The triple spring, pressing the two cells together, so as to press the placquets together gripping the nose, also presses the sides against the head, and takes away part of the pressure from the nose. This form of side combined with the spring-grip allows the frame to be easily put on into position without entanglement or disarrangement of the hair. 4. A new form of shell (banana-shaped) placquet, giving a comfortable, broad, bearing-surface on almost any nose. 5. Lightness of weight. This pattern weighs under three-quarters of an ounce as compared with the ordinary adjustable frame of one-and-a-half to two ounces. 6. Unusual stability and freedom from rock and wobble.

The advantages claimed for this pattern are that all the usual tiresome adjustments are done away with. The most satisfactory way of using it, is to offer it to the patient to be put on by himself, at the same time opening and closing the spring-slide, in order to demonstrate its action. If then, it should happen that the frame has not been placed close enough home to the face, one instantaneous adjustment on the part of the surgeon will complete the movement.

The frame does not slip down the nose away from the ears. Increase of weight, up to a certain point, actually makes the frame grip tighter on the face.

For presbyopic testing, the frame can be immediately tilted to any angle, or set at any distance on the nose away from the eyes without slipping or moving from the required position.

It may be argued in criticism, that such a frame will not fit or adjust itself to a face with:—

(*a*) Narrow-centered eyes and broad nose, and vice versa. (*b*) High-set eyes and low nose, and vice versa. (*c*) A twisted nose, or unequally-centered eyes. (*d*) Deep-set eyes and projecting nose, and vice versa.

This frame has been tried on many faces of all kinds, children and adults. Experience shows that the self-adjustability of the shell-placquets and the spring-bar, and the pressure of the sides against the sides of the head, allow of a speedier and more accurate adjustment to the face in a much greater proportion of cases than would be imagined. Even with faces of extraordinary measurements, its non-slipping properties and comfort to the patient outweigh any drawbacks that might have occurred from slight decentration.

Test lenses, "Final." This time saving device (see the cut) enables

"Final test" Lenses.

the user to place quickly before the patient's eye either a +0.25, plano lens, or −0.25 when finding the final correction. It is called, also, the "three-lens test." See p. 4744, Vol. VI of this *Encyclopedia*.

Test letters. See **Test charts.**
Test objects. See **Test charts.**
Test, Parallax. See p. 9257, Vol. XII of this *Encyclopedia.*
Test, Perls'. See **Siderosis of the eye.**
Test-plate. A finely-ruled plate used as a test-object.
Test, Screen. Duane's test. See p. 4683, Vol. VI of this *Encyclopedia.*
Test, Selection. See **Selection test.**
Tests for binocular fixation. See p. 961, Vol. II, as well as under **Binocular vision** in this *Encyclopedia.*
Tests for binocular vision. See p. 973, Vol. II of this *Encyclopedia;* as well as under **Stereoscope.**
Tests for dissimulation. See p. 7593, Vol. X, as well as under **Ophthalmology, Legal relations of,** in the middle third of the section.
Tests for exaggeration. See p. 7593, Vol. X, as well as under **Ophthalmology, Legal relations of,** in the middle third of the section.
Tests for false attribution. For testing false attribution of ocular diseases and injuries, see **Ophthalmology, Legal relations of,** in middle third of the section.
Tests for heterophoria. See p. 5911, Vol. VIII, as well as under **Muscles, Ocular** in this *Encyclopedia.*
Tests for malingering. See p. 7592, Vol. X of this *Encyclopedia.*
Tests for muscle-balance. See **Heterophoria.**
Tests for simulation of ocular diseases and injuries. See **Ophthalmology, Legal relations of,** in the middle third of the section; also p. 4671, Vol. VI of this *Encyclopedia.*
Test, Shadow. See **Skiascopy.**
Test, Shick's. See **Shick test.**
Tests, Laboratory. See **Laboratory technique.**
Tests, Ocular, for the presence of sleep. See **Ophthalmology, Legal relations of,** in the middle third of the section.
Tests, Pseudo-isochromatic. See p. 10424, Vol. XIV of this *Encyclopedia.*
Test types. See **Test charts.**
Test-types, Illiterate. See **Test charts.**
Test, Version. See **Version test.**
Tetanus, Ocular relations of. This disease is an acute infection—probably from the *Bacillus tetani* (q. v.)—in which there is a more or less constant (tonic) spasm of some of the voluntary muscles. It generally begins with stiffness of the jaw and esophageal muscles. Later *trismus* (lock-jaw) and other painful contractions of the body muscles set in, the temperature rises, and thirst, hunger and insomnia weaken the patient, who usually dies from exhaustion or asphyxia. Ocular tetanus is of rare occurrence, and follows wounds of the eye.

Wicherkiewicz (Abstract in *Ophthalmology*, April, 1908) observed the following case: The right lower lid of a boy, aged 15, was injured by the point of a stick. Three days later a contused wound of the skin, 2 cm. long, with purulent discharge, was seen at the lower orbital margin. The lower lid and cheek were swollen. The wound was carefully washed with a solution of boric acid, painted with 10 per cent. ichthyol salve, and covered with paper dressing. The next day trismus set in, and the patient was transferred to the department of infectious diseases, where a subcutaneous injection of 20 c.c. of tetanus serum was made. The attacks of trismus, however, grew more violent and almost constant, in spite of injections of morphin and chloral hydrate. Two further subcutaneous and intravenous injections did not save the patient from death.

R. Salus (*Klin. Monatsbl. f. Augenh.*, xlix, p. 322, 1912) reports a case in which a stick of wood passed through the lower lid of the left eye. The next day the eye was fixed. Four days after this the right eye also became immovable. Spasm of the frontalis, orbicularis, levator palpebræ superioris, and of other facial muscles, produced the characteristic *facies tetanica*. The palpebral fissure was narrowed, and yet closure of the lid could only be accomplished with great effort, as though against strong resistance. This resistance was furnished by the spastically contracted levator palpebræ superioris. The brow was wrinkled and the eyebrows drawn up. The position of the left eye was complicated by traumatic paralysis of the inferior rectus. Before full development of the tetanic state the pupils were normal; at the height of the disease there were anisocoria, miosis and almost complete pupillary rigidity. The writer finds in reported cases that if the tetanus toxin comes in direct contact with an eye muscle there develops a spastic condition of all the muscles of this eye, which after a short time radiates to the other eye and in other directions (the facial nerve, etc.).

W. Pincus (*Centralbl. f. prak. Augenheilk.*, Dec., 1911; abst. *Ophthalmoscope*, p. 367, June, 1914) reports the following case:—A man, aged 35 years, was struck in the left eye by a whip. He immediately felt great pain in the eye, and when seen next morning, the eye was intensely inflamed, with great chemosis and some proptosis. Nasally, between the limbus and ciliary region, there was a purulent prolapse of the iris. The globe was very soft, on account of loss of vitreous, and was full of blood. No perception of light. The wound was cleansed, the prolapse removed, and the scleral opening covered by a conjunctival flap. By the following day the inflammation and chemosis had increased, there was pus in the wound, and the picture was that

of a severe panophthalmitis. It was decided that as soon as the acute sypmtoms had passed off, the eyeball was to be removed. However, the condition became worse and the temperature rose. During the two following days, the proptosis increased, and on account of the possibility of orbital phlegmon, it was decided to remove the eye at once. The orbit was cleared, and for the next two days the patient was better. Three days after, the patient complained of difficulty in swallowing and in opening the mouth. The next day there was great trismus, paralysis of the left facial and right oculomotor nerves, ptosis, etc., and so he was given 100 units of tetanus antitoxin. The condition gradually became worse, and the patient died eleven days after the injury. At the autopsy no signs of meningitis or of pus in the orbit were found. In the eyeball, behind the iris, was found the end of a piece of whipcord, 5mm. long and 3mm. wide.

Vinsonneau (abstract in *Annals of Ophthalm.*, Oct., 1915, of *Arch. d'Ophtalmologie*, Vol. 33, p. 418, July, 1913), adds the twentieth case to date of *tetanus following ocular injuries.* The patient was an alcoholic youth, aged eighteen years. Four days previous to his admission he had applied to the country doctor, who found a slight scratch of the conjunctiva caused by an instrument which the patient had used to pry off a piece of wood. No foreign body could be seen and vision was good. That same evening, however, the patient found that he could not see with that eye. Four days later he was sent to Vinsonneau, who determined a beginning panophthalmitis. Enucleation under general anesthesia was done the next morning. Nothing of interest was seen in the wound on the following day, but the patient complained of a difficulty in eating and swallowing, which was attributed to the use of the mouth gag during the anesthesia, as no lingual or buccal lesion could be seen. Two days later the condition was the same. In the evening well marked tetanus had developed. The usual treatment was instituted, but intracranial injections through a trephine opening were not made because the patient was a minor and the case one of industrial accident. The patient died the next evening.

When earth has been introduced into an ocular wound Vinsonneau believes one should always use the antitetanic serum, and he prefers the intravenous and intracerebral to the subcutaneous method. In fresh cases one should inject the serum into the region of the sphenoidal fissure and the optic foramen. The writer prefers enucleation to exenteration, except in the case of young children, whose enucleation would give rise to hemiatrophy of the face.

Tetanus from a foreign body in the conjunctiva is reported by Na-

kano (*Oph. Year-Book*, p. 110, 1916). A woman 40 years of age was struck in the eye by a piece of wood, splinters from which were driven into the conjunctival sac. The lids were greatly swollen. Although the foreign matter was removed tetanic spasms set in and death followed.

From the same source we learn that Goetz, in his thesis, draws a number of conclusions in regard to *tetanus after orbito-ocular traumatisms*. The cases are rare: the points of entry of the bacillus are, in order of frequency: the eyeball, orbit, eyebrows, lids, and conjunctiva. The cornea permits of rapid diffusion of the poison through its numerous nerve plexuses. Infection is almost invariably due to contamination by earth or by equine dejecta. It is rarely of operative origin. There are three varieties: a, trismus; b, facial paralysis; c, eye troubles, chiefly paralysis or contracture of the ocular muscles.

The prognosis as to life is more serious than that of general tetanus; it is serious in proportion to (1) rapidity of onset, (2) depth and degree of contamination of the wound, (3) length of time the foreign body has remained in the wound, and (4) delay in beginning prophylactic injection of serum. Treatment is twofold: (1) removal of the focus of infection, (2) serum therapy. The latter gives the best results by intravenous and subarachnoid injection. Schneider has been able to find only sixty cases in the literature during the last hundred years. He reports a personal case and another unpublished compiled 371 cases of tetanus known to have occurred in Denmark, but there was not a single eye case among them. In Okuse's case splinters of wood were forced into the conjunctival sac and remained there. The lids were greatly swollen and tense. The pieces of wood were removed, but fatal tetanus followed.

Tetanus bacillus. See p. 741, Vol. I of this *Encyclopedia*.

In discussing the cultivation of the tetanus bacillus from the pus of a traumatic panophthalmitis, with remarks on prophylaxis in cases of eye injuries infected with tetanus, Wirtz (*Klin. Monatsbl. für Augenheilk.*, June, 1908) reports a case of a child of eighteen months admitted with a ragged perforating wound of the cornea. There was prolapse of the iris and vitreous, and the anterior chamber was full of blood. No history of the injury was forthcoming. The wound was trimmed and cleaned, and covered with a conjunctival flap. Forty-eight hours after the injury the child was fevered, there was great edema of the lids and chemosis, and the eye was full of pus.

At this stage further inquiries revealed the fact that the father had injured the child's eye with the lash of a whip used for driving swine.

The pus from the eye contained many different organisms, some of them morphologically resembling the bacillus tetani. Twenty units

of tetanus antitoxin were administered, the eye eviscerated and the sclera cleaned out with oxycyanide. The tetanus bacillus was isolated in cultures and its identity confirmed by the results of animal experiments. The other organisms were Bacillus subtilis, B. mycoides, B. proteus vulgaris, B. coli communis, Staphylococcus pyogenes aureus, and two others not identified. Either of these in sufficient numbers might by itself have caused panophthalmitis.

After removal of the eye, healing was uneventful. It is impossible to say whether, if left to itself, tetanus would have developed; or whether the exenteration or the antitoxin was answerable for the favorable result, but the author considers that both measures were demanded. Though the use of antitoxic serum has greatly reduced the mortality from tetanus, it is not a certain preventive. Local treatment, such as surgeons employ in other parts of the body, is not applicable to the eye without injuring its function, and in perforating wounds nothing short of evisceration or enucleation can insure the removal of the source of infection.

Wirtz discusses the arguments for and against removal of the eye in cases of injury in which the tetanus bacillus has been found or its presence suspected. Perhaps his experience with this case has rather biased him in favor of radical measures, but as he himself suggests, each surgeon must be influenced in his treatment by the known frequency of tetanus infection in the district in which he works.

Tetany, Ocular relations of. Although the term tetany is occasionally employed with and regarded as synonymous with tetanus (q. v.), yet the former is generally regarded as a distinct symptom. It is characterized by painful and symmetric spasm of the muscles of the extremities, and occurs mostly with lamellar cataract, typhoid fever, rickets, cold, diarrhea and excision of the parathyroids. It is probably due to a toxic agent, usually lasts for several weeks and, as a rule, ends in recovery.

Fischer and Triebenstein (*Klin. Monatsbl. f. Augenheilk.*, March-April, 1914) found positive evidence of latent tetany in sixty-eight cases of *senile cataract*. In twelve cases of corresponding age without lenticular opacity, ten were negative, one positive and one doubtful as regards tetany. From their investigations they believe that there is a close pathogenetic connection between tetany and senile cataract, and that every case of senile cataract should be examined by a neurologist and tetany ruled out before a diagnosis of simple senile cataract is made.

Zonular cataract and tetany. Out of 43 cases of zonular (lamellar) cataract, examined by Hesse and Phelps (*Zeitschr. f. Augenhk.*,

April, 1913), 35, i. e., 81 per cent., had undoubted symptoms of tetany, 4 were almost positive, making a total of 90 per cent. with tetany. Six of these cases showed affections of the bones, but only 2 had severe rachitis, with very slight changes in the lens and no changes of the teeth. Twenty-two out of the remaining 29 cases of tetany exhibited affections of the teeth. Out of the 8 cases of zonular cataract without distinct tetany only 1 rachitic, 5 showing anomalies of the teeth.

Hesse and Phelps do not think that zonular cataract is the only affection of the lens in tetany, since they had recently observed 34 cataract patients of youthful age, in whom tetany existed or had previously existed. They had in the majority of cases total cataract or various forms of partial opacities of the lens.

The authors conclude that tetany is the etiological element of zonular and many other forms of cataract at a presenile age. They emphasize the fact that they do not identify tetany with tetanic convulsions and do not attribute the cause of the affection of the lens to these symptoms. The tetanoid convulsions are only a partial phenomenon of tetany, the condition also presenting a series of motor, sensitive and vasoneurotic disturbances, changes of metabolism and the blood, from which the characteristic trophic anomalies, especially of the ectodermal structures, as skin, nails, hair, teeth, lens, develop. The pathogenesis of the whole multiform clinical picture, fluctuating in its symptomatology, must be ascribed to insufficiency of the epithelial corpuscles, which leads to peculiar pathological alterations in the co-ordination of the functions of the glands with interior secretion. See, also, p. 1774, Vol. III of this *Encyclopedia*.

In *tetany thyropriva*, Falta, Kahn and Zentmayer (*Journ. Am. Med. Assocn.*, July 7, 1917) found spasm of the ciliary muscle and a hypersecretion of tears.

Tetartanopia. Tetartanopsia. Absence of vision in a corresponding quadrant of each field.

Tetrachlorethane. This is a synonym of carbon bichlorid, a poisonous compound, much used during the Great War as "dope" (varnish) for aeroplanes and other purposes. In consequence there were reported a number of cases exhibiting oculotoxic symptoms.

Willcox (*Lancet*, London, 1, 544, 1915) quotes Heffter and Kraus, who state that in Germany, where the "dope" contains more tetrachlorethane than the English varnishes, two types of symptoms develop: (1) gastro-intestinal and hepatic, and (2) nervous symptoms. The latter group of patients suffers from tremors, headaches, pains

in the limbs, numbness, "pins and needles" of the extremities, loss of knee jerks and excessive sweating.

Koelsch (*München. med. Wchnschr.*, Nov. 16, 1915) also noticed among the more marked cases of tetrachlorethane poisoning various nervous phenomena.

Tetragon. A quadrangular figure.

Tetraiodopyrrol. See **Iodol.**

Tetranitrol. Nitroerythrol. A remedy usually administered for the purpose of reducing vascular tension, and indirectly intended to relive the intraocular pressure in glaucoma. It is used like nitroglycerin but is slower and more lasting in action than that drug.

Tetranophthalmos. A monster-fetus having four eyes.

Tetranopsia. A disordered state of vision in which there is obliteration of one-fourth of the visual field.

Tetrant. A quadrant.

Tetraotus. Tetrotus. A monster-fetus with two nearly separate heads, two faces, four eyes, and four ears.

Tetraspherical. Relating to four spheres.

Tetrastichiasis. A condition in which there are four rows of eyelashes.

Tetravaccine. A vaccine containing dead cultures of the bacteria of typhoid, paratyphoid A, paratyphoid B, and cholera.

Tetrophthalmos. A double-faced monster-fetus with two ears and four eyes. See **Congenital anomalies.**

Text books of ophthalmology. See **Ophthalmology, Literature of.**

Textor, Kajetan von. Father of Carl Textor, and himself a celebrated surgeon of some importance ophthalmologically. Born Dec. 28, 1782, at Marktflecken, Schwaben, Upper Bavaria, he received his medical degree in 1808 at Landshut. From 1808-10 he studied anatomy and surgery under Boyer, at Paris. He then took further courses in surgery at Pavia, Italy, chiefly under Scarpa, and, at length, was for a long time under the instruction of Beer at Vienna in "operations on the eye." Settling in Munich, he became assistant surgeon at the newly constructed general hospital in that city. In 1826 he accepted a call to the chair of surgery at Würzburg, a position which he occupied for many years with the highest honor to himself and to the school. In 1853, being 70 years of age, he was obliged to resign from his operative work. He was, however, allowed to continue his theoretical lectures on surgery until his death, Aug. 7, 1860.

Textor's most important writings concern the subject of operative surgery in general. Of special interest, however, to ophthalmologists,

is his "Ueber Star-Operationen" (*Deutsche Naturforscherversammlung zu Bremen,* Sept. 21, 1844).—(T. H. S.)

Textor, Karl. Son of Kajetan von Textor, and a surgeon of high repute, of some importance in ophthalmology. Born at Munich, Germany, Jan. 19, 1815, he received his medical degree in 1837 at Würzburg, his dissertation being "Ueber die Wiederergänzung der Krystallinse." He afterward studied in Munich, Vienna, Göttingen, Berlin, Copenhagen, Paris, and London. In 1843 he was made privatdocent in surgery at the University of Würzburg, and in 1850 extraordinary professor of the same subject in the same institution. He was pensioned in 1874, and died July 31, 1880.

Karl Textor's writings on surgery in general are of very high value, but cannot here be listed in detail. In addition to the excellent graduation dissertation, however, already mentioned, the following articles are of much importance in our specialty.

1. Ueber Ausrottung der Thränendrüse zur Heilung des Thränenträufelns. (*Journ. der Chir. u. Augenh.,* N. Folge, 1846, VI.)

2. Hornhaut-Erweichung nach Star-Operation. (*Ann. d'Ocul.,* Vol. XVI, p. 192, 1846.)

3. Angeborener Iris-Mangel. (*Jour. der Chir. u. Augenh.,* N. Folge, VII, 1847, 1, 204.)—(T. H. S.)

TGL. A symbol for a globin contained in a solution of tubercle bacilli in a 10 per cent. salt solution.

Thalamencephalon. The interbrain; one of the embryonic structures produced from the posterior part of the anterior cerebral vesicle, and developing into the part of the brain about the third ventricle, such as the optic tracts, the thalami, the infundibulum, the corpora albicantia, the conarium, and other parts. Called also *diencephalon* and *tweenbrain.*

Thalamometer. This is the name given by G. Raeder (*Norsk Magazine for Laegevidenskaben,* p. 862, 1918; abstract in *Am. Journ. Ophthalm.,* p. 292, Apr. 1919) to an instrument for measuring the depth of the anterior chamber. While using the binocular corneal microscope he ascribes his varying results in the same patient to the unconscious movement of the patient in the interval between the focusing of the instrument on the anterior surface of the cornea and the later focusing on the edge of the iris.

To overcome this difficulty he constructed a single-tube instrument by which the focusing on the two points (cornea and iris) is done simultaneously. This is accomplished by leading the rays from one-half of the field of the microscope through a series of adjustable prisms, allowing the images of the cornea and the iris to fall in the

same perpendicular plane and thus to be seen by the observer's eye at the same time. The depth of the chamber is read off directly on a scale attached to one of the prisms. Accuracy up to 0.1 mm. is claimed. The surface of the cornea is brought into view by dusting it with finely-powdered calomel or xeroform.

Since the anterior surface of the lens is difficult to observe, the edge of the pupil is used as the point of fixation.

Corrections are made for variations due to differences in the size of the pupil.

Thalamus opticus. See p. 6549, Vol. VIII of this *Encyclopedia.*

Thalictrum mexicanum. A Central American plant, the root of which is used in ophthalmia.

Thallium. A metal discovered in the seleniferous deposit of sulphuric-acid factories. Thallium is slightly heavier than lead—a metal which it resembles in its physical properties. It is very soft, being readily cut with a knife or drawn into wire; and its freshly cut surface exhibits a brilliant metalic luster and grayish color. In contact with the air it tarnishes more rapidly than lead, and becomes coated with a thin layer of oxide which preserves the rest of the metal. It fuses at 554° F. (290° C.), and at a red heat becomes volatilized. The metal and its compounds give a bright-green tint to colorless flames (hence the name *thallos*—Greek for "green"). It is used to produce a green light in firework displays, and is employed to render glass highly refractive. Thallium forms a number of compounds, including three oxides.—(*Standard Encyclopedia*).

Thaumatrope. An optical apparatus dependent for its effects upon the persistence of retinal impressions. It consists of a cylinder or disk upon which is depicted a series of images representing periodic phases of the same picture. When the disk or cylinder is rapidly revolved, the image of one phase persists while the image of the next falls upon the retina; so that the object seems to go through a series of movements. Known also as the enorthotrope; zœtrope, phenakistoscope and zœpraxiscope. See **Zœtrope.**

Theatre-glass. Opera-glasses.

Theinism. Theism. The ill effects of habitual excess in tea drinking. See **Tea.**

Theodolite. A surveying instrument for measuring horizontal and (in many cases) vertical angles, upon a horizontal graduated circle.

Theodore, The Blind Emperor of Epirus. Little is known concerning this potentate, and even that little is wholly to his discredit. He was known by many as "Theodore the Treacherous." He was by birth a Greek. In 1204 A. D., he seized upon Epirus, proclaiming himself

its emperor. He was finally captured and blinded by Asan of Bulgaria. However (so the story runs), Asan fell in love with Theodore's daughter, married her, and restored her father to the throne.—(T. H. S.)

Theodoti collyrium. (L.) An ancient collyrium containing castor, Indian nard, lycium, opium, myrrh, saffron, washed ceruse, aloes, calamine, copper scale, gum, juice of acacia, and rainwater.

Theomania. Religious monomania, often accompanied by hallucinations of sight, hearing and touch.

Theophanes Nonnus. A Byzantine physician of the 10th century, A. D. At the command of the Emperor, Constantinus Porphyrogeneta, he compiled from the writings of Oribasius, Ætius, Alexander and Paulus a book entitled *"Epitome of the Whole Art of Medicine."* The work is rich in the field of materia medica, poor, however, in pathology and surgery. A number of chapters, of no particular importance, are devoted to the ophthalmic materia medica.—(T. H. S.)

Theophilium. An ancient collyrium presented by Trallianus containing saffron, etc.

Therapeutic iridectomy. See p. 6577, Vol. IX of this *Encyclopedia.*

Therapeutics, Ophthalmic. Like other departments of medicine, ophthalmology can boast of a vast amount of literature concerning the treatment of disease; and here, as elsewhere, we find that the really valuable agents are few in number and that the epoch-making papers and books on ophthalmic therapeutics are even less numerous.

Ophthalmic therapy consists of three principal parts: (1) *operative measures,* (2) *optical appliances,* and (3) *medicinal agents.* Medicinal agents, using the term in a broad sense, include not only drugs used locally or internally, but also many physical agents, such as rest, heat, cold, massage, cauterization, the use of radium and the Roentgen rays, as well as injections (subconjunctival, intra-orbital, intra-venous, intra-muscular, and the use of tuberculins, sera, and vaccines), and the production of artificial hyperemia.—(J. M. B.)

The various remedial agents comprised in the three classes just mentioned are discussed under their individual headings and to these the reader is referred. Here a few additional observations are given.

A. Darier (*La Clinique Ophtalm.,* July, 1916; review *Br. Journ. of Ophthalm.,* p. 64, Jan., 1917) writes an *introduction to ocular therapeutics* from which we cull a few sentences.

The writer divides the methods of diagnosis under the following headings, namely (a) *Clinical diagnosis,* symptomatology. (b) *Anatomico-pathological diagnosis,* microscopic and bacteriologic. (c) *Experimental diagnosis,* animal inoculation. (d) *Sero-diagnosis,* devia-

tion of complement. (Bordet-Gengou, Wassermann, Cuti-epidermo-ophthalmo-reactions to tuberculin, Abderhalden's reaction.) (c) *Therapeutic diagnosis.*

Under the heading clinical diagnosis, Darier gives the first place to *dentition.* He believes that the canines may, in certain cases, be alone involved, but sometimes it is the first permanent molar which shows those stigmata of syphilis which Hutchinson has so well described for the front teeth. "It was," he says, "in 1900 that I made my first observations, and when, in 1904, I showed my casts to Sir J. Hutchinson himself, he admitted to me that he had not attached importance to molar lesions. He attributed these lesions to the influence of mercurial treatment. But it is easy to understand how the teeth which will be altered by syphilis will be those of which the ossification takes place at a time when this disease exercises its harmful effects. This explains why the first dentition is seldom involved: all the milk teeth have their ossification period in the fourth or fifth month of intrauterine life; if syphilis affects the fetus at this time, the latter is killed and abortion follows. If, on the contrary, syphilis manifests itself only in the final weeks of intrauterine life, it will interfere with the development of the only tooth which received its enamel cap at this time. That tooth is the first permanent molar." In a similar way the date of the syphilis can be determined by knowing the period of ossification of the other teeth. The whole of this paragraph on dentition is of very great interest.

As to the reactions of Wassermann, Noguchi, Abderhalden, and others the writer says that at the present time most of these reactions are too complicated for the average clinician to carry out himself. He looks forward to the time when so much simplification of *technique* shall be made that the ordinary ophthalmologist shall himself make these tests.

Of the many other observations that might be recorded here one of the most useful is that relating to *the economical use of solutions of costly alkaloids for ophthalmic purposes.* Solutions of cocain and homatropin are sufficiently costly at any time to render a method for their better preservation and economical use worthy of note. At the present time their cost is such that economy is more than desirable—it is a necessity.

For the past four years N. B. Harman (*Brit. Med. Jour.*, Aug. 5, 1916) has used, both in private and hospital practice, solutions of the various alkaloids required for eye work made up with minute quantities of antiseptic drugs, which in combination appear to have a more satisfactory effect in the preservation of the solutions than others in

common use; these small quantities of drugs can be added to the solutions of the alkaloids without objectionable effect. The drugs are well known, easily obtained, and in the quantities used negligible so far as cost is concerned. A stock bottle of "ophthalmic solvent" is kept in the hospital dispensary, and as solutions of cocain, etc., are required the stock bottle of solvent is drawn upon instead of the bottle of distilled water. The solvent is made up as follows:

Distilled water, 1 pint.
Methyl salicylate, 2 grains.
Oil of gaultheria, 2 minims.
Tincture of iodine, 2 minims.

The mixture is well shaken, poured into a stoppered bottle, and left for forty-eight hours, when it is ready for use. Different quantities of the drugs have been tried; the above proportions are those which are sufficient for preserving the solutions from contamination without producing objectionable effects in the use of the solutions.

Thermaërophore. A name given by Ostwalt (*Annales d'Oculistique*, March, 1905) to an appliance which consists of an elastic bulb, a spiral tube, and a soft rubber cup (with attached thermometer) large enough to fit over the orbit. Fresh air is driven by the bulb into the spiral tube, which is placed over a Bunsen burner, and the air heated by these means is then forced into the rubber cup. The dry, superheated air can be borne at a temperature of 100°, 150°, or 175° C. Treatment, given once or, occasionally, twice a day, is continued for about half an hour. The apparatus is intended to be used by the patient himself.

Thermal analysis. The analysis of radiation from any source for the purpose of determining the relative intensity of luminous and non-luminous rays in different parts of the spectrum.

Thermaphone. See **Heat, The ophthalmic relations of,** p. 5724, Vol. VIII of this *Encyclopedia*.

Thermo-cautery. Properly, any form of actual cautery; as commonly used, Paquelin's cautery. See p. 9244, Vol. XII of this *Encyclopedia*.

Thermochroic. Reflecting some of the heat-rays and absorbing or transmitting others.

Thermocouple. An electric battery made by joining two metals of unequal expansion by heat. See **Temperature.**

Thermolamp. A lamp for heating.

Thermo-luminescence. The property of various minerals to shine in the dark when hot.

Thermophore. THERMOPHOR. A metallic box or rubber bag filled with a mixture of glue, sodium acetate, sodium chlorid, and calcium sul-

plate. Dipped in hot water, it retains its heat for a long time, and is used in the local treatment of diseases.

Shahan's thermophor. This important device has been discussed already, in its relation to the thermotherapy of corneal ulceration, and the reader is advised to consult that caption. W. E. Shahan (*Journ. Am. Med. Assocn.*, p. 414, Aug. 5, 1916; and p. 1969, June 30, 1917) has given a full description of his instrument with an account of his experience with it.

The *thermophor* consists of a central brass tube one-half inch in diameter and 6 inches long with a walled off slot 4 inches long and five-sixteenths inch wide, cut into its side. This walled off rectangular space communicates directly with the interior of the tube and serves to contain a zinc-iron sensitive strip. One end of this sensitive strip is fixed to insulating material in one end of the slot; the other end is tipped with platinum plate and swings free. Around the brass tube and the rectangular space containing the sensitive strip, a sheet of insulating material is placed, and around this is wound about 6 feet of No. 26 nichrome resistance wire. One end of the resistance wire is fastened to the fixed end of the sensitive strip while the other serves as one of the terminals of the electric heating circuit. Over the end of the rectangular space in which the platinum tipped end of the sensitive strip swings is a small brass casing tapped for an 8-32 machine screw and fastened by means of insulating material to the central brass tube. The machine screw carries on its head a non-conducting disk of fiber. Its tip carries a platinum point. The screw is connected directly with the other terminal of the heating circuit. By revolving this screw, its platinum tip can be brought into contact with the platinum plate of the sensitive strip and current be made to flow through the resistance wire, generating heat. Almost immediately the zinc element of the sensitive strip will expand more than the iron, and carry the platinum plate away from the platinum tip of the regulating screw, breaking the circuit and stopping the heat. Shortly the strip will cool and the plate again come into contact with the screw point, reestablishing the circuit and heat flow for a few seconds. After oscillating for a short time, the temperature of the interior of the central brass tube will settle down to a nearly constant quantity.

When it is desired to use the instrument, a nickel plated brass heat-conducting head or applicator of the size and shape desired is placed within the central brass tube and allowed to project about one-half inch beyond its end. This projecting end is shaped to a definite size, and is intended to be placed in direct contact with the part of

the eye to be heated. The center of this applicator is drilled out as nearly as possible to its tip so as to contain a thermometer. In the end of the central brass tube opposite the end containing the applicator is a small brass collar with an aperture of a size just sufficient to admit the thermometer. When the thermophor is in use, therefore, the thermometer extends through its center and has its bulb in the exposed head of the applicator.

Around the above described resistance wire is placed suitable insulating material and the whole inserted into a tube of ordinary red fiber so as to make a neat looking instrument. The amount of resistance wire used in the instrument is just enough to get the desired heat when connected up in a series on a 110 volt current with a 32 candle carbon lamp. If connected directly with a 110 volt current, the amount of heat generated would shortly destroy the instrument. Up to 130 F. this instrument can readily be kept constant within 1 degree. Up to 150 F., variations of 1½ degrees may occur. The platinum terminals must of course be kept clean.

When this apparatus is set up for use, the common joint, where two German silver wires are soldered to one iron wire, the whole being insulated, is placed in the vacuum bottle which has been filled with cracked ice and water drained from it (the ice having been made from distilled water). It takes about three days for the ice placed in a vacuum bottle like this to melt; consequently a junction placed in such a bottle can be kept at constant temperature for that length of time, and the apparatus be constantly ready for use. The other junctions can then be arranged (say) so that one is in a groove in the top of the applicator of the thermophor, and in direct contact with the corneal surface, while the second is in the large calibration thermophor so that if the galvanometer should be accidentally jarred, it can be properly readjusted. With the apparatus thus set up, we are in a position to read off the average temperature of the applicator (from the thermometer in it), and the exact temperature in the transition plane between the tip of the applicator and the corneal (or other) surface, in quick rotation, and study any relation between them.

In these experiments it is necessary for the wires of the thermocouples to be insulated by some convenient material that takes up very little space. The best material found for this purpose is a celluloid varnish made by dissolving 15 gm. of sheet celluloid in 85 c.c. of acetone and 15 c.c. of amylacetate. This makes a firm, flexible, waterproof insulation entirely stable for the temperatures employed, and easily painted on with a camel's hair brush.

In his later paper Shahan (*Journ. Am. Med. Assocn.*, June 30, 1917) describes a simplified apparatus, *for one minute applications*.

To date of writing, ten cases of serpiginous (pneumococcus) corneal ulcer have been treated by the simplified thermophor. The results have been most gratifying. The infective process was stopped definitely in all but one case by one or two heat applications. It was found best, however, to use an initial temperature of 158 F. instead of 156 F. as being more certain to stop the process in one application of one minute's duration.

John Green (*Southern Med. Journ.*, p. 251, March, 1918) gives an independent and very favorable account of this thermophor, as follows: There is no evidence that the ocular tissues are damaged by 158° F. for one minute; the only immediate destructive effect is on the epithelium which is soon replaced. That the infection is checked is proved by the limitation of the spread of the ulcer, the disappearance of hypopyon and the control of pain. Even in cases where the infection is well advanced and perforation is inevitable, the thermophor will promptly put a stop to tissue necrosis, the perforation will be small and will tend to close so promptly that anterior synechiæ will not have time to form.

Thermoscope. An instrument for indicating variations of temperature without measuring their amount.

An instrument of this sort was devised by Georg Friedrich Sigwart, of Tübingen, for the purpose of measuring the temperature of the human eye in health and disease. It does not seem to have been very successful.—(T. H. S.)

Thermotherapy. The various aspects of the use and practical applications of heat in ophthalmology have already been discussed under **Hydropathy,** p. 6080, Vol. VIII; **Diathermy,** p. 3957, Vol. V; **Sweat bath; Baths, Sweat,** p. 910, Vol. II; **Thermophore; Cautery, Actual,** p. 1788, Vol. III; **Mineral waters,** p. 7831, Vol. X; and in particular under **Heat, Ophthalmic relations of,** p. 5724, Vol. VIII of this *Encyclopedia*. The reader is referred to these rubrics for information on this subject. To the matter to be found there are added a few observations on the *thermic treatment of corneal ulcer*.

Edward Jackson's *introduction* (Editorial, *Am. Journ. of Ophthalm.*, Feb., 1919) *of the subject* points out that from the first use of the actual cautery in the treatment of wounds down to the days of Pasteur and aseptic surgery, heat has been a reliable means of destroying infection. Increased knowledge of pathology and the recognition of pathogenic organisms have enabled us to apply it more exactly and effectively. But from the time when the cautery was first used to

check suppuration, the problem has been to do this completely with the least damage to the invaded tissue.

Since Martinache described his use of the actual cautery to check the progress of a corneal ulcer over 45 years ago, many instruments for such application of heat to the cornea have been employed, from the steel knitting needle held in an alcohol flame, or the copper ball

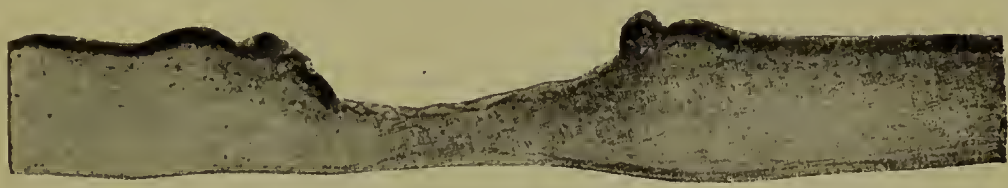


Fig. 1. Effect of cauterizing the cornea for superficial ulcer. Eye immediately enucleated. (Weekers.)

to hold the heat with a projecting point to touch the ulcer, to the numerous forms of galvanic cautery-tip mounted on handles of varied weight and convenience.

In 1892, Lippincott reported his favorable experience in the use of hot water dropped on certain corneal ulcers. He advised heating the water to 160° F., or over, and dropping it directly on the ulcerated surface.

In 1899, Bourgeois called attention to the sterilization of corneal ulcers by blowing hot air upon them. He used a bent metal tube

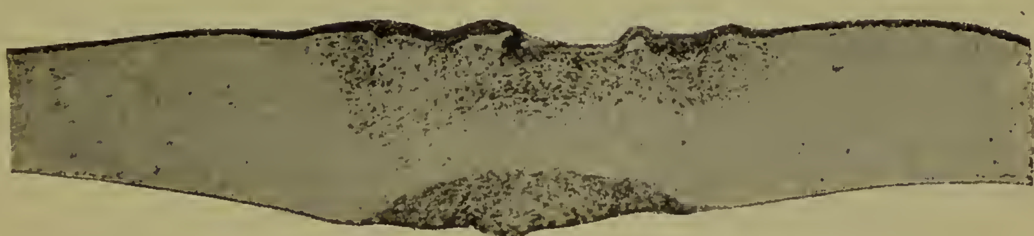


Fig. 2. Effect of cautery applied to superficial ulcer ten days after application. (Weekers.)

attached to a rubber bulb, similar to those used by dentists to dry cavities preparatory to filling. The tube is held in the flame of an alcohol lamp and the air drawn back and forth in the tube three or four times and then immediately expelled against the surface of the ulcer, which at once becomes white. The process can be repeated as often as necessary.

Eleven years later he reported, that depending wholly on this method for the sterilization of infected corneal ulcers, his results were truly remarkable. Rozet reported a similarly favorable experience with the method; but it seems not to have been widely practiced. The cauteri-

zation by live steam, which has been used in the frontal sinus by Dennis, seems not to have been tried for corneal ulcers. Boiling alcohol and other fluids that might furnish a perfectly definite temperature are also untried.

In 1910 Weekers published his method of applying heat to the cornea by holding the cautery point as close as possible to the ulcer without actually touching it.

Lastly, Shahan has worked out his thermophore (*q. v.*). The most important service that Weekers has rendered in this matter is his ex-

Fig. 3. Effect of cauterizing the cornea as seen at the end of three months. (Weekers.)

perimental showing of how little damage need be done to corneal tissue, by heat that will sterilize the pathogenic organisms.

The final determination of the best means of applying the precise and desirable degree of heat, must await a considerable experience with the different methods on the part of the profession in general. The hot air method of Bourgeois is extremely simple and easily applied and repeated. But on account of the greater penetrating power of radiant heat, the methods of Shahan, and Bourgeois seem more likely to reach and render innocuous the more deeply-seated organisms.

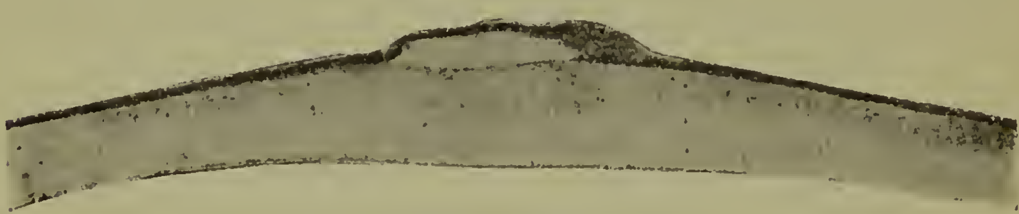


Fig. 4. Immediate effect of applying "chauffage" without cauterization. (Weekers.)

The treatment of corneal infections by heat will become more exact and its results more satisfactory in proportion as it is carried on with a clear understanding of exactly how much heat is needed and how much is being applied.

J. B. Lawford (*Oph. Review,* p. 148, May, 1914) has given a full abstract of L. Weekers (*Archives d'Ophtalm.*, Nov., 1913) important essay on the *thermotherapy of progressive ulcers of the cornea.* The

illustrations are from Weekers latest paper, published in the *Am. Journ. of Ophthalmology.* Weekers is a keen advocate of the treatment of severe forms of corneal ulceration, such as pneumococcal infections, by the direct application of heat (chauffage) as opposed to cauterization. He has already drawn attention to the favorable results obtained by this method, at the University of Liége, in a communication to the Belgian Ophthalmological Society in 1910; and in this paper now under review gives a further report of his experience.

The idea underlying the employment of heat in dealing with serpiginous ulcers of the cornea, is based upon the well-known intolerance of heat by the microbes usually responsible for these lesions. Cultures of the pneumococcus are sterilized in 24 hours at a temperature of 42° C., in 10 minutes at 56°, instantaneously at 65° and 70°. The diplo-bacillus of Morax-Axenfeld is killed in 5 minutes by a temperature of 55°. Moreover, without attaining a temperature which kills the microbes at once, it is possible, by the application of heat, to lessen their virulence or even to render them innocuous, and this without causing structural change in the corneal tissue. This is the principle of intermittent sterilization, of "pasteurization" as used in bacteriology, as in the preparation of culture media rich in albuminous content. For the rapid action of a high temperature, is substituted the prolonged or repeated action of a lower temperature. Weekers has found that the galvano-cautery is the simplest and most efficacious means of chauffage of the cornea. He employs it at a low incandescence, and as a guide to the degree holds the filament close to but not in contact with the reservoir of a thermometer: the mercury should not rise above 50°; obviously the degree of heat in the platinum point will be somewhat higher.

His procedure is as follows: The eye is anesthetised, and a speculum inserted; the platinum filament at a low degree of incandescence, as indicated above, is moved slowly over the whole surface of the ulcer, as near as possible to the cornea, but without touching it; special attention is directed to the advancing edge of the ulcer. This procedure lasts for one minute by the clock. Under the influence of the heated point the moist surface of the ulcer is subjected to a rapid evaporation and becomes dry. It is therefore advisable, at the expiration of a minute to intermit the chauffage and moisten the cornea by sterilized saline, or more simply by closing the eyelids for a few seconds. The heating is then repeated for the space of a minute. In this way, at one sitting, the chauffage is applied two or three times according to the severity of the lesion. In his early cases, the author applied the heat for several minutes and repeated the procedure on

successive days, but experience showed that these prolonged and repeated applications were unnecessary. It is exceptional for a case to require more than one, but if necessary a further application can be made a day or two later.

The clinical results of this method of thermotherapy at Liége have been very encouraging. During the preceding five years, in the University Clinique, all the cases of progressive ulcer of the cornea have been successfully treated by chauffage; in no single case has resort to cauterization been necessary. The effect of the chauffage is remarkable. By killing the micro-organisms, or by attenuating their virulence, it cuts short the advance of serpiginous ulcers; rapid retrogression occurs, the hypopyon disappears, and healing takes place in a few days. The influence of this treatment on the subjective symptoms is not less noticeable; in almost every case, immediately after the chauffage, pain is relieved and there is seldom any recurrence of it.

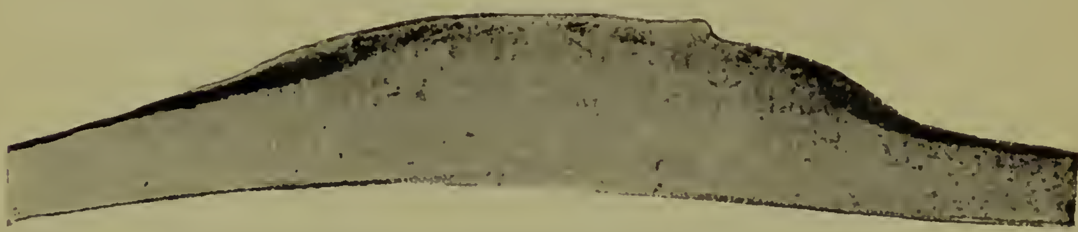


Fig. 5. Effect of ''chauffage'' three hours after its application. (Weekers.)

It is not surprising that healing of an ulcer should be more rapid in cases treated by chauffage than in those in which cauterization is employed. In the former class the destruction of corneal tissue is limited to that resulting from the disease; in the latter the cautery increases the area of destruction.

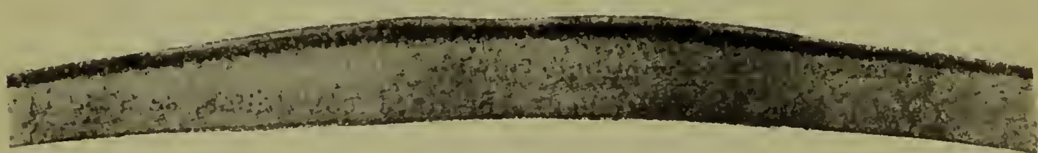


Fig. 6. Ultimate restoration of cornea almost complete after ''chauffage.'' (Weekers.)

Consequently the resulting scar is generally larger and denser after the employment of the cautery than after treatment by chauffage.

The writer does not attach much importance to statistics concerning the visual result of therapeutic measures in ulceration of the cornea; so much depends upon the position of the lesion, its severity, and the date at which treatment is begun. He finds, however, that

his results compare very favorably with those of cases treated by cauterization, and gives a list of 47 cases.

One of the advantages of this method of treatment over that by cauterization, is the lessened risk of perforation of the cornea and its disastrous consequences. In 64 cases reported by Vasek (*Annales d'Oculistique*, 1899, 1911), in which cauterization was employed, perforation occurred in 2 instances, at the time of cauterization, and in 9 instances at periods varying from 1 to 21 days afterwards. In Weekers' 47 cases, there was no instance of perforation at the time of the application of heat, and in only 2 cases at a subsequent date.

Bourgeois and Wessely (*Bericht d. Oph. Gesellsch.*, 1912) have both published papers dealing with the treatment of serpiginous ulcers of the cornea by the direct application of heat; the former employed hot air, and the latter a fine metal tube in which circulated steam or the vapor of alcohol; the degree of heat obtained was respectively 98° and 78°. The method suggested by Weekers is simpler and more easy of application.

Shahan's thermophore. This observer (*Am. Journ. of Ophthalm.*, p. 231, Nov. 1917; see, also, **Thermophore** in this *Encyclopedia*) has used his special device in thirty-two cases of serpiginous ulcers of the cornea and hypopyon keratitis of pneumococcus origin. The results have been so uniform and positive that the method can be said to be very nearly specific. There was rapid cessation of clinical symptoms and steady replacement of destroyed tissues, and the visual acuity finally obtained in these cases ranged from perception of light where very nearly the whole of the corneal surface had been destroyed before the thermal treatment was used to full normal where the treatment was used before the onset of severe iritis.

The mode of application is as follows: After anesthesia and bleaching by means of several instillations of 5 per cent. cocain in 1:2000 adrenalin, the applicator is placed upon the corneal ulcer and held there one minute. The extremity of the applicator should be of a size to cover the ulcer exactly; it is heated exactly to 158° F. There is no pain during the application but some for a few hours afterwards.

Thermotype. A picture impression developed by the action of heat.

Thielmann, Karl Heinrich. A well-known Russian physician, who devoted considerable attention to ophthalmology. Born at Nicolai, Dec. 7, 1802, he studied at Breslau, St. Petersburg and Dorpat, at the latter institution receiving his degree in 1832. For a time he was engaged in military service, and treated with much success an epidemic of ophthalmia in a number of military hospitals. In 1850 he was made honorary oculist to the imperial court. He wrote a large

number of articles on ophthalmologic subjects, all in the Russian language, and died Aug. 14, 1872.—(T. H. S.)

Thiersch graft. See **Skin-grafting**; **Transplantation**, and in particular pp. 1055 and 1057, Vol. II of this *Encyclopedia*.

Walter Parker (*Oph. Year-Book*, p. 300, 1916) has made a valuable practical suggestion in this connection. After preparing the surface, the skin and knife should be *smeared with a thin coating of sterile vaselin* to eliminate the tendency of the skin to move with the knife. After some unsatisfactory results with rubber protectives he has adopted the open-air treatment, consisting of a somewhat concave, freely perforated piece of aluminum held in place by adhesive plaster and covered with gauze. No other dressing is used except the dusting powder. His results have been entirely satisfactory.

Thigenol. This remedy may be regarded as a rival of ichthyol. It is a mixture of sulphur and soda in oil. It is given a place here because of its curative value in the severer forms of blepharitis marginalis, especially the ulcerative varieties. It is a dark-brown, odorless compound quite soluble in water, glycerin and alcohol. No ill effects upon the ocular structures are reported from its prolonged use. It is obtained in solution from organic sulphur after the reduction of sulphuric acid by means of oil of sweet almonds. It can be incorporated with vaselin, lanolin, etc. The actions of the drug are antiseptic and analgesic. Fortunati recommends it for eczema of the lids in ointments of 5 to 10 per cent.; blepharitis marginalis 10 to 50 per cent.; blepharitis ulcerosa, 10 per cent. It is applied to the edges of the lids, while gauze smeared with the salve, from 10 to 60 per cent., should be left on all night. The next morning after these applications the lids are carefully cleansed with an alkaline solution and pure thigenol used. The results of this treatment are excellent, a cure sometimes resulting in 25 to 40 days.

In phlyctenular keratoconjunctivitis the drug is useful in 5 per cent. solutions. Deep ulcer of the cornea yields to a solution in glycerin, 10 to 50 per cent. The pain is relieved and usually the ulcer begins to undergo repair in 5 to 6 days. In different forms of infective conjunctivitis the drug is used in 3 to 5 per cent. solution.

Del Monte (*Archivio d'Ottalmologia*, Nov., 1905) found thigenol to be of great service in dacryocystitis, conjunctivitis and keratitis. He believes it to be useful in 10 per cent. solution for irrigating the lachrymal passages after operation; in all kinds of blepharitis it has a beneficial effect and its action may be considered as specific in the forms kept up by epiphora. The agent is efficacious in herpes of the conjunctiva and cornea, especially when accompanied by marked

irritation and watering. Thigenol in the last two mentioned diseases is perferable to the red precipitate and the yellow oxide of mercury, because it causes no irritation and does not easily deteriorate in the form of ointment. Corneal ulcers do not contraindicate its use.

Thin lenses. See p. 7247, Vol. X of this *Encyclopedia*.

Thioform. Basic bismuth dithiosalicylate. This agent is a yellow-brown, odorless powder, insoluble in water, containing 72 per cent. of bismuth oxide. This antiseptic is one of that numerous class of bismuth compounds recommended as a protective and dusting powder in place of iodoform. It is employed in substance and is conveniently applied by means of an insufflator or a camel's-hair brush.

The Editor (Hare's *System of Therapeutics*) believes that in acute cartarrhal conjunctivitis, when there is much secretion, finely powdered thioform acts very nicely when flecked upon the previously cleansed conjunctiva.

Thiol. A blackish-brown powder formed by the action of sulphur on coal-tar oil, and soluble in water and alcohol. It is used internally and externally in various skin diseases, and occasionally in eye affections. Dose, 2-10 gr. See **Sphagnol.**

Thiolin. A dark-green substance prepared by boiling 1 part of sulphur in 6 parts of linseed oil, and treating the product with sulphuric acid. It is used like ichthyol in skin and eye diseases.

Thionin. A dark-green dye or stain, giving a purple color in solution, and used as a stain in microscopy. See **Nicolle's stain,** and p. 6917, Vol. IX of this *Encyclopedia*.

Thiophen. A colorless oily benzine derivative, which is miscible with water.

Thiosinamin. Allyl sulphocarbamid. Allyl thiourea. Rhodallin. According to Wood's *System of Ophthalmic Therapeutics*, p. 569, this agent is a complicated organic compound made by warming together volatile oil of mustard and alcoholic solution of ammonia. The product forms colorless crystals with an odor of garlic and a bitter taste. It melts at 74° C. (165° F.) and dissolves in 3 parts of alcohol. It is moderately soluble in water but soon after decomposes. This decomposition is partly prevented by adding glycerin to the solution. The internal dose is 0.03 grm. to 0.1 grm. (½ to 1½ grains) given in tablets or capsules, but its most effective mode of exhibition is as hypodermic injection, the dose ranging from 0.05 to 0.25 grm. (1 to 5 grains) in 15 per cent. alcoholic solution or 10 per cent. glycerin-water solution. Since this method is painful fibrolysin (q. v.) is a better form of subcutaneous administration.

Thiosinamin is stated by Pick to be of good service in thick leuco-

mata. He prescribes a subconjunctival injection of 0.5 c. c. of a solution of 2 grm. of thiosinamin in 20 grm. of water and 4 grm. of glycerine, corresponding to 0.45 grm. of fibrolysin (1-5 of an ampulla) once a week. Brandenburg has also tried the preparation in the form of intramuscular injections in corneal opacity following keratitis scrofulosa, keratitis purulenta, keratitis trachomatosa, in chronic uveitis and chronic retrobulbar neuritis. Some of the patients said they could see better, but no appreciable improvement could be shown.

The success following the use of this remedy in softening and dissolving scar tissue led to its employment in similar conditions about the eye, as in lid scars, in corneal maculæ, symblepharon, extensive pterygium, etc. Many favorable reports have been published on this subject. For example, K. H. Grunert found thiosinamin of use in lupoid scars of the skin and in post-neuritic atrophy. In the former case, the author used a solution of 4 grm. (gr. 60) of thiosinamin in 8 grm. (gr. 120) of glycerin and 40 grm. (oz. 1 1-3) of water; in the latter case, the same solution with the addition of 0.2 grm. (gr. 3) of strychnin nitrate. Of this 1 cc. (m. 16) was injected into the muscles, at first daily, then at gradually increasing intervals. The remedy acts by softening and diminishing post-neuritic connective tissue formations in the optic nerves. The addition of strychnin is only needed at the beginning of the treatment, for when once the improvement has come to a standstill, the improved condition may be maintained by means of thiosinamin alone. The author's statement that the condition invariably grows worse if the treatment be left off too soon is of some importance.

The results obtained by D. Bruno by the use of fibrolysin (q. v.) in eye work are worthy of note. It acts beneficially in softening scar tissue in leucomata after the subsidence of keratitis with hypopyon. Well-marked leucomata, which seriously interfered with vision, he reduced to slight nebulæ by injections of fibrolysin into the glutei, or into the back. These injections were found to be equally efficacious in cicatricial spots resulting from syphilitic iritis, and exudative choroiditis. In many cases they were useful in softening and loosening the scar tissue, and thus facilitating further treatment.

Suker has also published favorable reports on the use of thiosinamin in corneal scars, but the Editor has not been able to obtain as marked benefits from its employment. He says that the cases in which thiosinamin is indicated are: 1. Corneal opacities from any cause whatsoever. 2. Cicatricial contractions of the lids following trachoma. 3. Certain intra-ocular inflammations, as exudative choroiditis. 4. Sym-

blepharon. 5. Capsular opacities following cataract extractions (experimental). 6. Ectropion, especially cicatricial. 7. Plastic iritis.

Speaking of the mode of administration Suker remarks that opinions differ widely. Some, like Black, Newton and others, prefer the hypodermatic injections, two or three times a week. Again others, as Tousey, Ruoff and Beck, give preference to the administration per mouth. The weight of experience is in favor of three-grain capsules once or twice a day. The hypodermatic injections are not very desirable, as the solution does not keep very well. Not only that, but abscesses are prone to follow; this has been the Editor's experience. For topical applications, a 10 per cent. ointment is the most efficient. The latter can be applied two or three times a day in conjunction with massage of the part.

The idea of employing subconjunctival injections of thiosinamin for corneal opacities occurred but a short time ago. The fact that it is used locally for keloids led to the experiment. A 10 per cent. aqueous glycerinated solution was used. Of this 15 minims were injected three times a week after thoroughly cocainizing the eye. The injections are not painful, nor do they cause any great inconvenience.

J. L. Duncan has had excellent results from 1 grain doses (in capsules) three times a day in both old and new corneal opacities.

Third cervical ganglion. The largest of the three cervical ganglia. It is situated on the rectus capitis anticus major muscle, behind the internal carotid artery, and opposite the second and third cervical vertebræ. It is connected with the four upper cervical and the vagus, glosso-pharyngeal and hypoglossal nerves, and gives off numerous branches to adjacent structures, the most important being those to the pharynx and to the superior cardiac nerve. See **Sympathetic system.**

Third intention. Of the older writers, the union of wounds by the growing together of the granulations on their sides. *Union of granulations* is the more recent term.

Third nerve. Motor oculi. The nerve distributed to all the external muscles of the eye except the superior oblique and external rectus. See p. 409, Vol. I of this *Encyclopedia.*

Thiuret, Amblyopia from. Thiuret is an antiseptic, crystalline powder whose salts (hydrobromide, salicylate, phenolsulphonate) are employed in medicine. According to Baar (*Das Gesichtsfeld,* p. 173, 1896) it has produced a toxic amblyopia with symptoms resembling those produced by iodoform (*q. v.*).

Thomas, Charles Monroe. A well-known homeopathic ophthalmologist and oto-laryngologist of Philadelphia. Born in 1850, he received

the medical degree at the Hahnemann Medical College, Philadelphia, in 1871. Four years later he became demonstrator of surgery in the same institution, and from that time until 1906 was actively connected with his alma mater: professor (afterwards emeritus professor) of operative surgery, ophthalmology and otology, dean of the school (from 1903 to 1906), etc. He married Miss Marion E. Turnbull. His death occurred at his country home near Westchester, Jan. 14, 1916.—(T. H. S.)

Thompson's eye water. A quack eye lotion of varying popularity in America.

Thompson, Daniel A. The son of James Livingstone Thompson, who was himself a well known ophthalmologist. Born in 1862, in Rush Co., Ind., he received his medical degree at the Medical College of Indiana in 1883. Having served for a time as house physician in the Indianapolis City Hospital, he studied ophthalmology in 1885-'86 in London and Vienna.

Returning to Indianapolis he became associated with his father, and so continued until his death. In 1890 he succeeded his father as professor of ophthalmology in the Medical College of Indiana, and taught consecutive courses until 1904. He was ophthalmologist to the City Hospital, St. Vincent's Infirmary, the Deaconess Hospital, the City Dispensary and the Eleanor Hospital for Children. He was a good operator and a most excellent teacher. His personal character was of the highest.

Thompson died at his home in Indianapolis, Oct. 22, 1904, after an illness of three weeks. He had been with his wife and children at the Louisiana Purchase Exposition, in St. Louis, and there, owing to the great heat and overexertion, he contracted an inflammation of the liver which was followed by an abscess.

Thompson left a wife, a son and a daughter, as well as a sister, who is now the wife of Dr. John H. Oliver, of Indianapolis.—(T. H. S.)

Thompson, Homer Warren. An ophthalmologist and oto-laryngologist of Salem, Ohio, well known locally. Born at Salem, Dec. 8, 1859, son of Joseph Warren and Hannah Ann Thompson, he received the medical degree at Pulte Medical College, Cincinnati, in 1885. He married, on April 12, 1900, Miss Cora May Owen. He was a well known aeronaut. His death occurred from angina pectoris, Feb. 8, 1918.—(T. H. S.)

Thompson, James Livingstone. An American ophthalmologist, widely celebrated throughout the Middle West, and one of the best loved doctors of his day. Born in London, England, October 5, 1832, he came to

America while still a small child. He began the study of medicine at St. Paul, Minn., but soon migrated to Chicago, where he received his degree from Rush Medical College in 1860. Shortly afterward he settled in Shelby Co., Ind., but, on the outbreak of the War, became assistant surgeon to the Fourth U. S. Artillery, colored. In 1864 he was promoted to be major and surgeon, and surgeon of the post, Columbia, Ky., and medical director of Western Kentucky. In October, 1865, he resigned from military service.

Settling in Harrison, Ohio, as general practitioner, he removed, about two years later, to Cincinnati, Ohio, where he studied ophthalmology with Dr. Elkanah Williams. In 1871 he removed to Indianapolis, where he practised ophthalmology until his death.

In 1874 he was made professor of ophthalmology and otology at the Medical College of Indiana, a position which he held for nearly fifteen years, when he was succeeded by his son, Daniel A. Thompson. Later, he was made emeritus professor, and, after the death of his son, he once more taught until the end of the year. In 1883 he became president of the Marion County Medical Society, and in 1890 was a delegate to the International Ophthalmologic Congress at Milan, Italy. In 1892 he was chairman of the ophthalmologic section of the American Medical Association. In 1894, by invitation, he read before the British Medical Association a paper entitled "Unusual Forms of Opacity of the Crystalline Lens."

Dr. Thompson, however, was not so much a writer as an operator and man of affairs in medicine. Absolutely ambidextrous, he worked both rapidly and well. His results, especially in cataract operation, were almost uniformly excellent. He was the life of his college and also of his local medical society, and was an enthusiastic and reliable leader in everything he undertook.

Dr. Thompson was happily married, and to him and his sunny-hearted wife were born a daughter and a son. The wife passed from life in 1898, the son in 1904. The daughter, Mrs. John H. Oliver, resides in Indianapolis.

Dr. Thompson, after many years of charity and mercy toward his fellow men, died in Indianapolis, Mar. 5, 1913.

He was a man of many friends and of the highest Christian character. He became a member of the church in childhood, and, in Indianapolis, was a member of the Meridian Street Episcopal church. His favorite books were *The Pilgrim's Progress* and the *Bible*. His friends were very numerous and belonged to all the social classes—the rich, the poor, the low and the high. Among his closer intimates were Senator Beveridge, Meredith Nicholson, Charles Richard Wil-

liams and James Whitcomb Riley. Among the latter's writings are the following lines, penned as descriptive of Dr. Thompson:

"His every feature speaks his mental force;—
Jawed like a vise; a nose like any prow
Fronting the storm; such eyes as in their ire
Do seem to singe; and the high, vasty brow
O'ertopping all, a tow'ring bleak Mont Blanc
Of lordly individuality."

The following sonnet, by Charles Richard Williams, though not so widely known as the lines of Riley, should also be preserved in this *Encyclopedia:*

TO JAMES LIVINGSTONE THOMPSON.

He was a man! In all the ways of life
Strong in his purpose, clear of mind and will,
Who knew men's weakness and yet loved them still.
A man of peace, but not afraid of strife,
Who knew when balm was needed, when the knife
Which Science taught him to control with skill.
A duty once acknowledged, to fulfil
Was all his thought; and so his days were rife
With high endeavor and with noble deed,
Binding his friends to him with links of love
That are not broken at life's broken span.
With vision bounded by no man-made creed
He faced the infinite future, where, above
Earth's stress, we believe he still abides, a MAN.

It was a very unusual crowd that viewed the remains of Dr. Thompson, and the mingling of the various classes in that crowd was perhaps the purest, as well as the highest, tribute that could possibly have been paid to him. The Doctor's loftiness of soul, his gentle courtesy and tender-heartedness, had in fact drawn unto him all sorts and conditions of men, women and children.

Because of the dignity of the funeral sermon—the finest, perhaps, that was ever uttered above the ashes of an ophthalmologist, we reproduce it here in the form of an extended epitome:*

"Doctor Thompson was a man of sincere faith and high ideals, of

* This sermon was delivered by the Rev. Joshua Stansfield, pastor of Dr. Thompson's church.

wide culture, noble enthusiasm in his profession; reticent, refined; a charming gentleman, a scholar, a Christian. Those of us who knew him best, loved him for what he was and what he did. The key to Doctor Thompson's character was his deep and abiding faith in the elemental and eternal things of religion and of life—God, truth, virtue, righteousness, immortality. For such a life there is but one outcome. Doctor Thompson has gone to be with God. The argument for immortality as known in the intuitions, aspirations, yearnings, longings and hopes is a consciousness rather than a dogma, and Doctor Thompson, our friend, knew it, and so, while to-day we may sorrow, we sorrow not as those who have no hope. We believe that goodness is imperishable. It is of God and returns to God. It is said of Jesus that it was not possible that he should be holden of death. So, too, and always, the best of life is imperishable. It goes forward to the larger realization and expression of itself. Goodness is of God and abides; so, too, with all best qualities of human life. Goodness, mercy, wisdom, justice, truth and love, we speak of in God as eternal qualities, and are they not also such in man. Our moral intuitions, our deepest faith, our truest hope, all say they are, and Christ our Lord confirms this, in the words—If it were not so I would have told you. He that believeth in Me shall never die. Even though he were dead, yet shall he live again. Because I live, ye shall live also.

"And now we shall take the earthly remains of our brother and friend, the sweetness of whose life is symbolized by the flowers about his casket, and shall lay them away, in sure and certain belief that the dead in Christ shall live again."—(T. H. S.)

Thompson, John Tatham. A celebrated Anglo-Am. ophthalmologist. Born in New York in 1857, his early education was received at the Bortham school in his native city, and also in London, and at the Bristol University College. He entered the medical department of the University of Edinburgh in 1880, and received from this institution the degree of M. D. and C. M. For a number of years he studied ophthalmology under Argyll Robertson. Settling in Cardiff, he became ophthalmic surgeon to the Cardiff Infirmary, and, twenty years later, consulting ophthalmic surgeon to the same institution. He was also, at various times, surgeon oculist to the South Wales Institute for the Blind; Medical Referee for the South Wales District under the Workmen's Compensation Act; Chairman of the Cardiff Division of the British Medical Association and of the Medical Board of the Cardiff Infirmary; President of the South Wales and Monmouthshire Branch of the British Medical Association; and Vice President

of the Ophthalmological Society of the United Kingdom. He wrote a large number of papers, but no books. He was an excellent artist, and made nearly all the illustrations for Woodhead's *"Practical Pathology"* and absolutely all of those (so justly celebrated) for Berry's *"Textbook of Ophthalmology."* He was a caricaturist of the first rank, and the humorous drawings which he made of his professor and his fellow students, during the years of his college life, are, many of them, preserved until this day, by some of the noted physicians and surgeons of England. Even in later life, he was "a valued cartoonist on the Liberal side at rectoral elections." His chief recreation was golfing. He was a prominent Mason, a founder and past master of the Prince Llewelyn Lodge 2570 at Cardiff, and held high office in the Knights Templar and Rose Croix Masons. He was very popular in society, an accomplished converser and after-dinner speaker and reciter. He died at his residence in Windsor Place, April 28, 1911, after a long and painful illness. As he was a Major in the R. A. M. C. Territorials, he was given a military funeral.—(T. H. S.)

Thompson, Robert. A well-known American general practitioner and ophthalmologist, inventor of Thompson's cornea knife and Thompson's cataract needle. Born in Washington Co., Pennsylvania, in Septembed, 1797, he was licensed to practice medicine in 1824 and ten years later received the honorary M. D. from the Medical College of Ohio. He married in 1824 Ann M. Seeber, of New York State. He was one of the founders of the Ohio State Medical Society, and its president in 1847. His most important ophthalmic article is "Cataract" (*Trans. Ohio State Med. Soc.,* 1859). Thompson died at Columbus, Ohio, Aug. 18, 1865.—(T. H. S.)

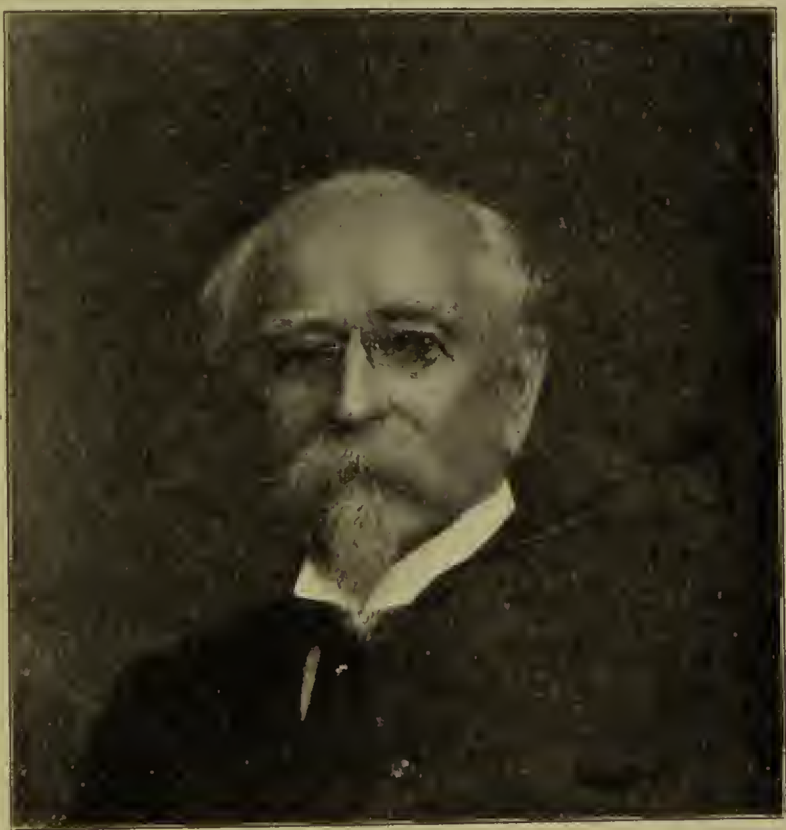
Thomsen's disease. MYOTONIA CONGENITA. See p. 8277, Vol. XI of this *Encyclopedia.*

Thomsonianism. THOMSONISM. A system of medicine, now practically extinct, devised by Samuel Thomson, of Massachusetts. It maintained that the human body is composed of four elements—earth, air, fire and water; also that, since metals and minerals are heavy and are obtained from the earth, their employment for therapeutic purposes will tend to draw those who use them downward toward the earth, whereas, as vegetables develop upward, the use of them tends to develop and benefit those who employ them. This system was, in a limited fashion, employed in the treatment of eye diseases.

Thomson, William. One of the best known of American ophthalmologists, inventor of Thomson's "color-stick" for worsteds and Thomson's color-test lantern-devices in almost universal employment. Born

at Chambersburg, Penna., Jan. 28, 1833, he received his medical degree at Jefferson Medical College in 1855. He settled at once as general practitioner at Merion, a suburb of Philadelphia, and in 1857 was married to Miss Rebecca George, of Merion.

He served throughout the Civil War in a medical and surgical capacity. At the very beginning he entered the regular army as assistant surgeon, and in 1862 was chief of staff to Dr. Letterman,



William Thomson.

who then was medical director. In 1863 he was surgeon-in-chief to the Douglas Hospital, at Washington, and in 1864 was made inspector of the Washington Hospitals. In 1866 he was promoted to the rank of captain.

He seems to have had his attention directed to ophthalmology by his own high degree of hypermetropia, D. 5.00. Finding that he read much better when his pupils were strongly contracted by a bright light held up close to his eyes, he set about to ascertain the cause of this phenomenon. Deciding to devote himself to ophthalmology, he resigned from the army in 1868, and began to study the diseases of the eye in Philadelphia. In that city, too, he settled, in course of time, as ophthalmologist. In addition to the color-stick and the

color-lantern, he invented a perforated disc for the better performance of Father Scheiner's experiment, and a refractometer based on the principle of circles of diffusion. Both these instruments were highly praised by Landolt, who devoted considerable space to them in his "*Refraction and Accommodation of the Eye.*" He was, at various times, attending surgeon to the Wills Eye Hospital, lecturer, honorary professor, full professor and professor emeritus of ophthalmology in the Jefferson Medical College.

Dr. Thomson died Aug. 3, 1902, after a day of unusual exertion, of uremic poisoning.

A list of Dr. Thomson's more important ophthalmic writings may be found in "*Trans. of the Coll. of Phys. of Phila.*," 3 s., 1909, Vol. XXXI, and in Kelly's "*Cyclopedia of American Medical Biography,*" II, p. 447.—(T. H. S.)

Thorascope. An instrument for examining the pleural cavity. It is pushed into the cavity through an inter-costal space.

Thorington's axonometer. See p. 4722, Vol. VI of this *Encyclopedia.* Another model of the device is depicted in this text.

Thorington's Axonometer.

Thorium. A rare metal resembling aluminum, but taking fire below a red heat, and burning with great brilliancy. *Thoric*, ThO_2, the oxide, is remarkable for its high sp. gr., 9.2. Thorium was discovered in a rare black Norwegian mineral termed *thorite*. The dioxide is used with zirconia for making incandescent gaslight mantles. In the twentieth century thorium has assumed a new importance in virtue of its radio-active properties.

See **Radiotherapy**, p. 10849, Vol. XIV, and under **Mesothorium**, p. 7660, Vol. X of this *Encyclopedia.*

It may be added here that in all probability *different parts of the human eye are unequally reached by radiation with thorium*, on account of

the different effect and absorption of the component rays. The action of the alpha rays in water penetrates only to a depth of 1/10 mm. Consequently they cannot enter the eye through the cornea. The beta rays are absorbed two hundred times more effectually than the gamma rays and act on the human tissue to a depth of from 7 to 13 mm.

G. Abelsdorf (*Klin. Monatsbl. f. Augenheilk.*, 53, p. 321, 1914) attempted to prove this experimentally on rabbits and a very elaborate series of trials were made by him with various thorium compounds and rays but in the opinion of the Editor results obtained by the use of lower animal eyes alone (and especially by the employment of the eyes of rodents) are, in this instance as in others, not of much value.

Of about equal practical value with the foregoing are the experiments of Stargardt (*Zeitscher. f. Augenheilk.*, Vol. 34, p. 195, 1916). This observer injected neutral solutions of thorium X in quantities equal to the radiation of 0.0045 to 0.00225 mg. radium bromid *into the anterior chamber of rabbits.* From two to four weeks after the injection into the anterior chamber a very characteristic decoloration of the iris was observed, due, as histologic examination showed, to a decay of the chromatophores and more or less severe lesion of remaining tissue of the iris, especially the endothelium and the walls of the blood vessels, and of the endothelium of the cornea, sometimes leading to its complete destruction.

Injections of solutions equal to the radiation of 0.009 radium bromid into the vitreous of rabbits destroyed directly or indirectly the parts of the eye most important for vision; caused liquefaction and opacities of the vitreous from accumulation of lymphocytes; destruction of all layers of the retina; necrosis of the retinal vessels; atrophy of the optic disc and obliteration of vessels; disappearance of the stroma cells of the choroid and changes of the choroidal vessels like those of the retinal vessels. The ciliary body showed strikingly slight alterations. Clinically the iris presented no changes, but histologically the chromatophores were disintegrated, and the vascular endothelia were slightly affected.

Thorn-apple. Datura. A genus of plants of the natural order of *Solanaceæ,* having a tubular five-cleft calyx, a large funnel-shaped, five-lobed corolla, a two-laminated stigma, and an imperfectly, four-celled, prickly, or unarmed capsule. The species of this genus are annual herbaceous plants, rarely shrubs or trees; they are in general narcotic, and productive of wild excitement or delirium. The common thorn-apple, or stramonium (*D. stramonium*), is an annual plant, with smooth stem and leaves, white flowers, and erect, prickly capsules, a native of the E. Indies, but now often met with in Europe, and also

in Asia, the N. of Africa, and N. America. It contains a peculiar alkaloid, *daturine,* which is practically identical in its action with atropine. The leaves and seeds are employed in medicine.—(*Standard Encyclopedia.*) See pp. 3749 and 3750, Vol. V of this *Encyclopedia.*

Thorner's demonstration ophthalmoscope. The attempt to render it possible for *two persons*—especially teacher and student—*to observe the same fundus oculi at the same time* is an old one (see p. 3814, Vol. V of this *Encyclopedia*), but Walter Thorner (*Zeitschr. für Psych. u Phys. der Sinnesorg.,* 20, p. 294, 1899) came nearest to realizing this scheme. In the words of the makers of Thorner's instrument, this ophthalmoscope gives a clear image of the eye ground and enables two observers simultaneously to make a minute study of the details of the fundus. The image is quite motionless and shows under strong magnification and illumination a great variety of details which are very difficult to catch with the ordinary hand ophthalmoscope. The image is *free from all corneal reflexes;* the magnification equals that of the erect image; the field of view with dilated pupil is 4 to 5 times as extended as that of the inverted image obtained with a 3 inch lens. If the pupil of the observed eye is less than 7 mm. in diameter, the field of view diminishes horizontally; vertically it is always the same.

The *abolition of the corneal reflexes* may be understood from the diagram. The light L is placed in front of a convex lens A of large aperture the distance of L to A is twice the focal length of the lens; an image of L is thrown upon the pupil O_2. *This* image is of the same size as the light L. The fundus is examined in the indirect image by means of a convex lens B having a focal length of 25 cm. The lens is placed midway between the observer O_1 and the observed eye O_2, 50 cm. from each. An image of the fundus is formed between O_1 and B; this image is distinctly visible to the observer O_1. Let one half of the light L be covered by a screen $s\,s$, an image of $s\,s$ is then formed upon one half of the pupil O_2 $b\,c$, that is to say this half of the pupil becomes dark while the other half $a\,b$, remains illuminated. The unilluminated half of the pupil, bc, forms its image upon half of the pupil O_1 cf, while the illuminated half throws its image upon the other half of O_1 de. All the rays reflected from the illuminated half of the cornea of O_2 behave as if this half were self-luminous; these rays form an image of ab in de, whereas in the space cf no ray from this reflex can fall. If a second screen be placed in de the reflex is completely abolished; only the light from the fundus of O_2 enters the observer's eye O_1 (gg is a reflecting glass plate).

A similar combination (Fig. 2) serves for illumination and observation; the combined system resembles an astronomical telescope,

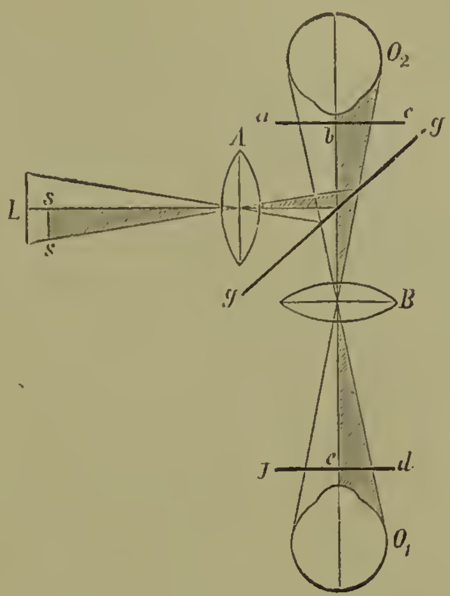


Fig. 1. Diagram explaining the Absence of Corneal Reflex in Thorner's Demonstration Ophthalmoscope.

modified to meet the special optical construction of the eye. It consists of two bi-convex lenses of 75 mm. focal distance, and 50 mm. in diameter, and a smaller plano-convex lens of 75 mm. focal distance

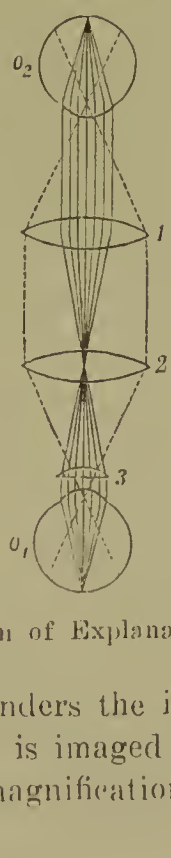


Fig. 2. Diagram of Explanation. (Thorner.)

likewise; this combination renders the image sufficiently achromatic: moreover the concave fundus is imaged as a plane. The linear magnification = 1, so that the magnification is the same as that of the

erect image. The light is thrown upon the eye O_2 from the illuminating combination by means of a totally reflecting prism (not shown in the figure). Departures from emmetropia on the part of the observed as well as of the observer's eye can be corrected by changing the distance between 1 and 2, if the error is slight: in higher degrees of ametropia, the ocular lens 3 is to be exchanged for another.

Fig. 3. Thorner's Reflexless Demonstration Ophthalmoscope.

In using Thorner's demonstration ophthalmoscope the pupil of the observed eye must be dilated at least until the observer has become somewhat expert in the use of the instrument. Eyes with corneal or lenticular opacities, or high degrees of astigmatism are not adapted for examination with this ophthalmoscope. High decrees of hypermetropia and myopia are no hindrance. Homatropin offers a ready means for securing the requisite dilatation.

P is the place for the patient, *A* for the observer and *D* the place

where the demonstrator can arrange the apparatus for the observer *A*. (Fig. 4.)

To examine the left eye, a lamp (*L*, Fig. 4) preferably with a red chimney is to be placed to the right and somewhat behind the patient; to examine the right eye the lamp is to be similarly placed but on the left (*R*, Fig. 4). The patient sees the lamp *L* in the mirror *l* with his right eye when his left is being examined; he sees likewise the lamp *R* with his left eye in the mirror *r* when his right eye is being examined. The lamps *L* and *R* are intended only as guides to the patient to direct his eyes properly.

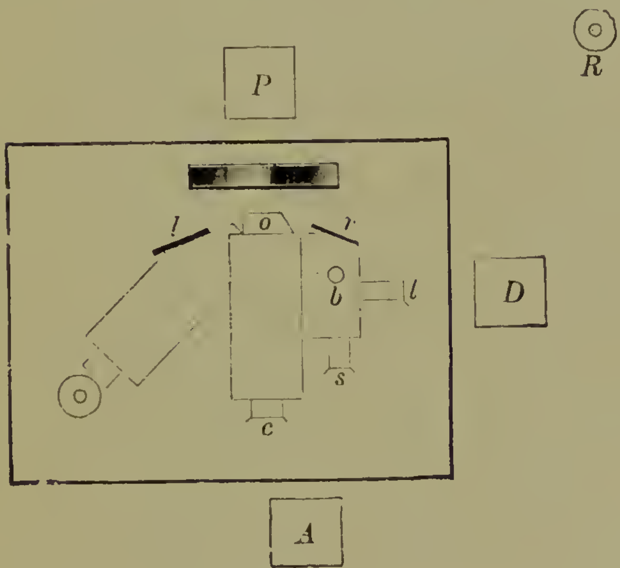


Figure 4.

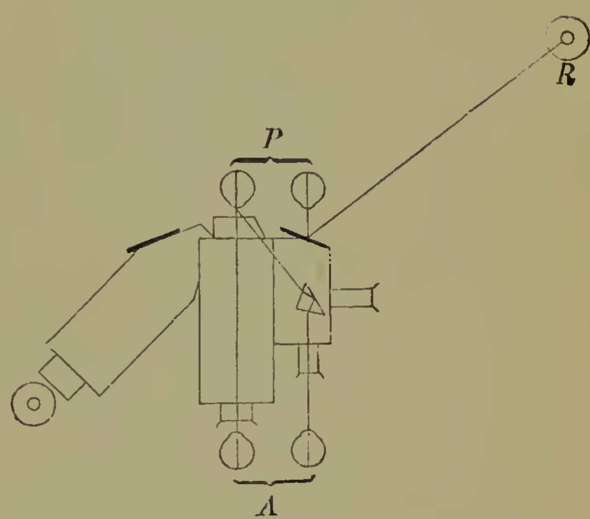


Figure 4a.

Thorner's Demonstration Ophthalmoscope.

The lamps are so placed that the nerve head of the examined eye shall come into the center of the field of view. To determine where the lamp should be placed the observer may take the patient's seat with the chin resting on the left half of the chin rest and both eyes open, the lamp *R* should be seen close to the left of the illuminated circle (Fig. 5); with the chin upon the right half of the chin rest, the lamp *L* should be seen close to the right of the illuminated circle (Fig. 5). If we wish to examine different parts of the fundus, we have the fixation lamp moved about by a third person; the patient is to follow these movements.

The patient rests his chin upon one of the two chin rests, upon the left if his right eye is to be examined; and upon his right if his left eye is to be examined; he is to keep both eyes open and look at the lamp *L* or *R* respectively in the mirror. The apparatus is to be then

brought into such a position by the horizontal and vertical hand screws that the light from the opening *o* (Fig. 4) falls upon the pupil of the examined eye.

The examiner seats himself at *A* and turns the handscrew *b* (Fig. 4) at the top of the apparatus to the right as far as it will go. (In some ophthalmoscopes is to be turned the whole upper cover of the finder instead of the handscrew *b*.)

If the observer looks through the finder *s* with his right eye he will have a view as in Fig. 6, *1*—*8*, Fig. 4a shows the position of the patient's two eyes, if his right eye is being examined; it also shows the observer's eyes if he himself is regulating the apparatus. If no bright semilunar light is seen upon the patient's eye by the observer through the finder (Fig. 6, *1*) it indicates that the patient is not close enough

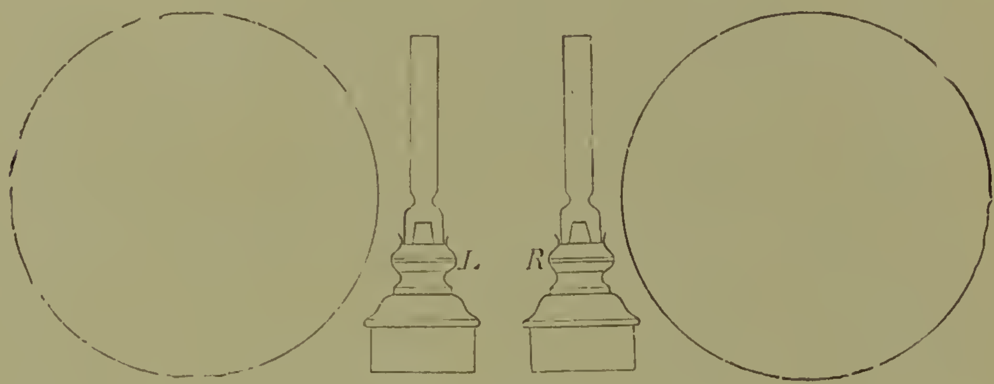


Figure 5.

Thorner's Demonstration Ophthalmoscope.

to the apparatus. As the patient comes closer the convex edge of the half moon is first seen upon his eye (Fig. 6, *2*). As he comes still closer the light gets wider (Fig. 6, *3*), and finally when an unilluminated part of the eye has also come into view to the left of the bright half moon (Fig. 6, *4*) the patient is close enough to the apparatus, viz.: 1 cm. from the opening *o* (Fig. 4). The two hand screws are then to be turned until the bright half moon covers exactly the right half of the pupil (Fig. 6, *5*). When in this proper position almost the entire unilluminated left half of the pupil, as well as the illuminated right half is seen through the finder. Fig. 6, *4*, shows the half moon too high. The apparatus must be lowered by the vertical screw; Fig. 6, *6*, shows it too low; Fig. 6, *7*, shows it too far to the left; Fig. 6, *5*, shows the proper position with the dilated pupil; Fig. 6, *8*, gives the proper position with the undilated pupil.

When the apparatus is properly adjusted as above described, the

observer looks with his left eye into the observation tube c (Fig. 4); the instrument is focused by pushing this tube in or out by a handle attached below it. If the patient moves his eye the movements are noted by the observer with his other eye, the right, the instrument being regulated accordingly while the observer continues to observe with his left eye.

If a sharp focus can not be obtained by pushing the sliding tube in or out, the observed eye being too hypermetropic or myopic, the eye piece *E* (for emmetropia) is to be placed by one of the three others (*M* and *MM* for high myopia, *H* for high hyperopia). If the image is to be shown to another, the demonstrator takes his place at *D* (Fig. 4) and the observer at *A*.

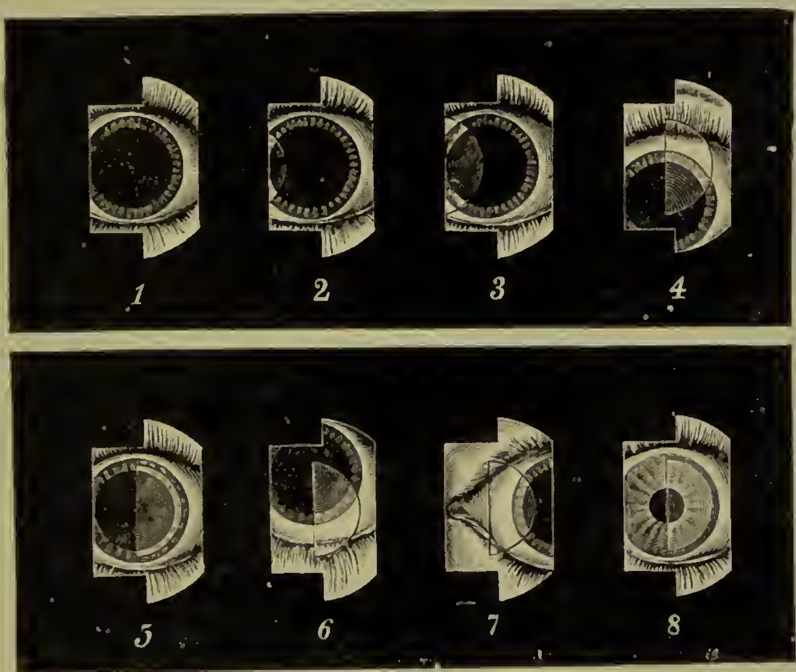


Figure 6.
Showing Adjustment.

The handscrew *b* (Fig. 4) is to be turned to the left as far as it goes (respectively the upper cover of the finder must be turned) the demonstrator sees in the tube *t* the same phenomena as before through *s*. If the observer at *A* is not emmetropic he may either make the examination with his correcting glass or compensate his own error by focusing the instrument.

If the observer at *A* can not see clearly with the finder, he is to replace the ocular *O* by + 4 or — 4 (attachments which come with the instrument). If it is desired to soften the light of the lamp, as when the examination is made with the undilated pupil, or if it is prolonged, especially when the macula is under scrutiny, the screw attached to the chimney will interpose a smoked glass in front of the light.

If the observer *A* can only see with one eye and desires himself to regulate the apparatus following the movements of the patient's eye, an attachment may be secured by means of which the examiner can use the finder with the same eye with which he is observing the eye ground.

The normal fundus reflex can be well seen with this apparatus; the patient is to be placed about a meter from the opening *o;* he is to look somewhat laterally. The observing tube is to be directed to the face of the patient, both eyes will be seen to give a bright reflex, no matter in what direction the patient looks. To see this the room must be dark.

Thorner's refraction ophthalmoscope. This is quite a different instrument from the inventor's demonstration ophthalmoscope (q. v.). Thorner (*Zeitschr. f. Psych. u. Phys. der Sinnesorg.*, Vol. 33, p. 187) endeavors to measure human refraction objectively by accurately focusing the patient's fundus. The inventor claims that, with practice, the refraction can be determined within a quarter of a diopter.

The following notes are abstracted from the makers' circulars. Atropine is first employed in the usual fashion. The *adjustment* of this instrument is in general the same as that of Thorner's demonstration ophthalmoscope (q. v.).

The *scale* (see the figure) for reading off the refraction does not become visible until the lamp of the ophthalmoscope is lighted; the reading is effected by means of reflection in a reading-off-case which is fixed above the scale. By turning a knob, fixed on the right hand side of the reading-off-case, the mirror in this case can be moved round a horizontal axis forward or backward as far as a ledge. If the mirror has been turned forward as far as the ledge, the scale is visible to the observer himself, who must, in order to read off the scale, slightly raise his head from the position adopted by him while observing the patient's fundus oculi. If the mirror has been turned backward as far as the ledge the scale is visible to a person sitting by the side of the observer, should the latter—in order to facilitate the examination—prefer not doing the reading himself.

There are always visible three divisions, one by the side of the other. They are marked with the letters *M E H* respectively and always refer to the ocular marked with the corresponding letter. No division has been made for ocular *M M* (such extreme myopia occurring but very seldom) and, furthermore, the accuracy of the determination in cases of this nature being greatly affected by the slightest alteration in the distance between the eye and the apparatus. Should,

however, a division of the aforesaid description be required, it can be supplied. If desired, the oculars can be arranged in revolving frames in order to facilitate exchanging them.

The division is made from ¼ to ½ dioptrie. The through lines indicate the units of dioptrie, the half and quarter lines the fractions in between. A horizontal line etched on a glass plate serves as an index.

Fig. 2 shows the index on scale *M* to be between — 10.75 and — 11.0 D., rather nearer to the former dividing line, so that we have

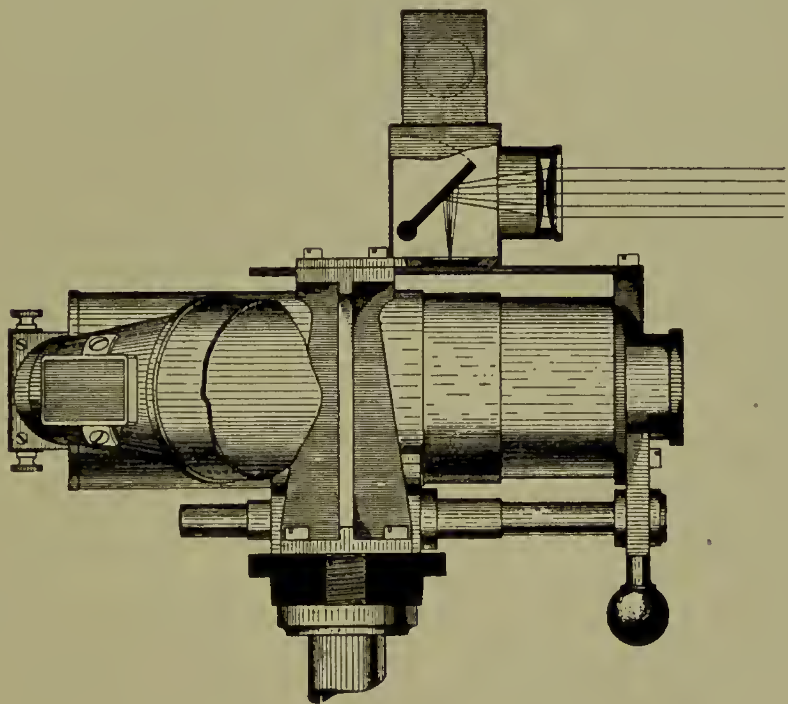


Figure 1.

Thorner's Refraction Ophthalmoscope.

to read off — 10.75 D. On scale *E* the index indicates — 0.25 D., on scale *H* + 4.75 D. By the sign + (as is usual) hypermetropia, by the sign — myopia is denoted.

After having accurately focused the patient's fundus oculi the observer should try to draw out the observation tube as far as possible without the image becoming indistinct, in order to relax his own accommodation as much as possible. By focusing repeatedly (each time independent of the other) he will readily be able to gauge the accuracy of his observation.

In the event of the observer himself not being emmetropic, he should correct his refraction anomaly by a glass placed in front of the observation tube. The reading-off-case is arranged so that the scale

appears perfectly clear only to an eye focused to infinity, the object being to enable one to read off without exerting one's accommodation, so that the observer's eye may remain in the same state of accommodation while observing the fundus oculi and reading off the scale. Any remaining slight myopia may be taken into account, as is done when determining refraction in respect to the *erect image* so that, in the event of the observer having, despite his correcting glass, still left myopia of — 1 D., he has to add + 1 D. to every result. If he

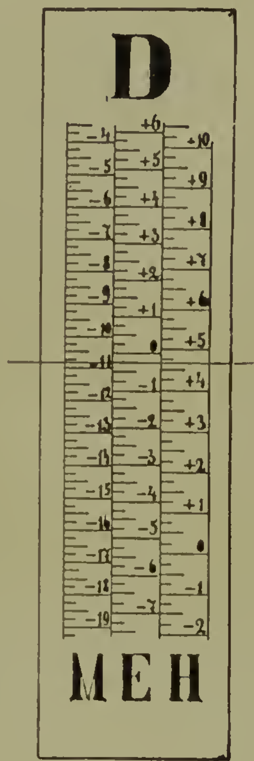


Figure 2.

Scale used in the Thorner Refraction Ophthalmoscope.

finds, therefore, in such case + 3.5 D., the proper result is + 4.5 D., if he finds — 6 D., the proper result is — 5 D. Should the observer be hypermetropic, without correcting himself by means of a glass, he had better have the scale read by somebody else, as otherwise he might feel tempted to maintain the exertion of accommodation, required for reading off the scale, when observing the fundus oculi.

Care should be taken so that the part of the fundus oculi, whose refraction is to be determined, is nearly in the center of the field of view, the marginal zones of the field of view differing in refraction by slight values from its center. The most important point at which the refraction must be determined is the macula lutea, where one is able to very conveniently focus with accuracy the great number of small

vessels that are within the field of view of the apparatus. To this end one requests the patient to look direct at the light circle.

For measuring *astigmatism* one had better utilize the fine vessels of the macula region and then accurately focus those which vanish vertically to the meridian whose refraction is to be ascertained. To find the weakest refracting meridian, one pulls out the observation tube as far as possible and observes which vessels are the last to clearly appear. The meridian vertical thereto, is the weakest refracting one, whereas the meridian these vessels disappear in, is the strongest refracting one.

The determination of astigmatism may also be accomplished by putting concave cylindrical glasses of varying strength in front of the oculars and ascertaining, by turning, that position where the crossing vessels of the macula region appear well defined at the same time.

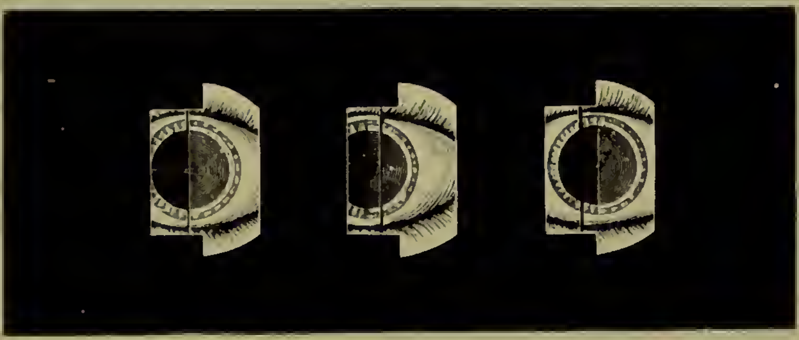


Figure 3.

Images of the Cornea in the Thorner Refraction Ophthalmoscope.

Thus the correct position of the meridian is likewise conveniently ascertained.

As zero-point of the dioptric-scale, viz., the point whose refraction is $\pm \infty$ D. the anterior focal point of the eye under examination has been adopted. The division on this apparatus thus indicates the eye's internal state of refraction.

In cases of great refraction anomalies, the distance of the eye from the instrument is of importance. To enable observers rapidly to ascertain these values, Thorner has elaborated a table.

In the higher degrees of myopia or hypermetropia it is important for accurate determination of the refraction that the eye be kept at a certain distance from the front aperture of the apparatus. The searcher is provided with a contrivance for determining the refraction, a mark that indicates when the cornea vertex is exactly 10 mm. from the front aperture. As shown in Fig. 3, the correct distance is indicated by the black line running from top to bottom. This

coincides exactly with the border between the light and dark half of the pupil, Fig. 3a; whereas in Fig. 3b the eye is too far from, and in Fig. 3c too near the apparatus.

Thränenapparat. (G.) Lachrymal apparatus.

Thränenmangel. (G.) A deficient secretion of tears.

Thränensackentzündung. (G.) Dacryocystitis.

Three-level line. In alphabets and print for the blind (q. v.), this is a plan in which dots appear on three lines, upper, lower and middle.

Threshold. That degree of stimulus that just produces a sensation: a stimulus that is barely appreciable or that just comes within the limits of perception.

Threshold, Achromatic. The least intensity of the spectrum that produces a sensation of color. Reduction of intensity below this point produces a sensation of brightness only, without any color distinction.

Threshold of visual sensation. The *minimum visible*, or slightest possible vision of any object.

Threshold values of depth. Schweitzer (*Oph. Year-Book*, p. 388, 1913) used the stereoscoptometer to determine the threshold values of the faculty of depth perception in a series of patients, grouped according to their age and also according to the time which had elapsed since the loss of one eye. Since the results, under equal conditions, have varied considerably in the reports of different observers, he believes the test incapable of furnishing satisfactory criteria for the establishment of a normal threshold value for those recently deprived of one eye. The influence of familiarity with the apparatus in shown in the strikingly rapid improvement obtained in the same patient after a number of tests. Some old persons give favorable results, while on the other hand some young persons who have been deprived for years of the sight of one eye show quite unfavorable results. A low threshold value (ability to return correct answers for short distances of the test objects from the eye) on the part of a one-eyed person at the first examination is not proof that he previously used the retained eye alone or preeminently in the visual act and especially in the estimation of depth.

Threshold values of color. See **Threshold values of light and color,** *infra.*

Threshold values of light and color. George Young (*Br. Med. Journ.*, p. 722, June 29, 1918) having found that a normal standard, quite as uniform as that for visual acuity, exists for light and color, recently attempted to standardize a *series of test objects* which can be universally used for determining how near to, or how far from, the normal

standard each individual eye is. In diseases of the retina, the choroid, and the optic nerve, very remarkable variations from the normal are found. Young has reason to believe that abnormal thresholds are not limited to diseases of the eye; marked changes in the thresholds are certainly to be found where the ocular implication is secondary. Walter Sinclair has pointed out that in several of his cases of retinitis of pregnancy the threshold for yellow was the only one attacked, but that very considerably, and the writer has found the same in the only case he has seen since. The threshold for yellow was reduced to recognition of the dilution 1 in 4, instead of the normal 1 in 32.

Young gives his ideas of what is meant by the *threshold for light.* If in a railway train we pass through a long tunnel and there is complete darkness even after adaptation, we notice on approaching the exit a moment when the first glimmer of light is perceived. This is the threshold for light. A patient whose light sense is reduced will not perceive light till some time after the normal sighted do.

As regards the *threshold for light differences:*—The stars are always in the sky, but we only see them after sunset, because though there is a difference in light intensity between them and the sky, even in daylight, there is not sufficient difference for the human eye to distinguish them. The threshold for differences of light intensity is reached the moment the evening star becomes visible, or the instant the morning star fades out of sight. We would distinguish the evening star sooner than our friend in the train, and would still see the morning star after it had vanished for him. Young finds that when the threshold for light is reduced, that for light differences is equally so. A test of the latter is incomparably more simple, and for all practical purposes sufficient. It becomes practically a measure of the light sense.

The threshold for colors. These are quite distinct from both the previous ones. They are indicated by the very first tints perceivable in the clouds when we watch the horizon at dawn, and the very last trace of color in the sunset clouds before all is gray.

That the periphery of the retina is more sensitive to these thresholds is easily observed by watching the Pleiades. If a point more or less remote from this group be fixed on the sky, a far greater number of its stars evoke our light sense than if the group itself be fixed.

The point to decide is whether, under what conditions and to what extent these thresholds have any clinical value for diagnosis, differential diagnosis, or prognosis.

Throat, Relation of diseases of, to eye. See **Cavities, Neighboring,** p. 1810, Vol. III of this *Encyclopedia.*

Thrombophlebitis, Orbital. See p. 9107, Vol. XII of this *Encyclopedia.*

Thromboplastin. This agent is a true physiological hemostatic, acting neither mechanically (like alum, tannin, and salts of iron) nor by constriction (like epinephrin, adrenalin and the like) but by furnishing to the blood-stream certain highly essential thromboplastic substances and properties. It is, specifically, a tissue-juice prepared from the brain of the ox, then physiologically tested and standardized, and, finally, rendered aseptic by three-tenths of one per cent. of tricresol. Its chief constituent is kephalin, an organic phosphoric acid compound, which has long been known as a valuable hemostatic. Thromboplastin is said by its manufacturers "to control or arrest most hemorrhages" but not "to stop that from the free end of a large artery." It is cheap, portable, aseptic and ready for immediate use. It also seems to be wholly devoid of dangerous properties.

Other substances than thromboplastin, which act in a similar manner and which have been to some extent employed for the arrest or control of hemorrhage, are normal serum, blood platelets, and certain other products of horse blood. But, in using these, there is always the danger of previous sensitization, while, after the employment of thromboplastin, anaphylaxis is said to be unknown. Neither has thromboplastin been known to produce glycosuria, atheroma, or degeneration of muscular fibres (especially those of the heart)—all of these being well known consequences of the use of epinephrin and the like.

Thromboplastin is administered locally, hypodermically, and by the stomach. In tonsillectomy it appears to be of extreme value, preventing hemorrhage and infection, lessening shock, and facilitating convalescence. "When local applications fail, it should be injected into the site of hemorrhage" (Squibb). According to Hess (*Journ. Am. Med. Assocn.*, p. 1719, Dec. 9, 1916): "In addition to its hemostatic action, this tissue extract has been found to possess healing properties, actively stimulating granulation tissue and hastening epithelization. It is therefore applicable as a dressing for torpid ulcers and for sluggish wounds." The chief value, however, of thromboplastin lies in its hemostatic properties. Ophthalmologists, like all other surgeons, are, at times, compelled to operate in cases of pernicious anemia, obstructive jaundice, and hemophilia, and, in all such conditions, thromboplastin will be found of the very highest value.—(T. H. S.)

Thrombosis of cavernous sinus. See p. 1794, Vol. III of this *Encyclopedia*.

Thrombosis of emissary vein of Santorini. Embolism of the cavernous sinus (q. v.) is sometimes accompanied by edema over the mastoid and this sign is explained by a thrombosis of the emissary vein of Santorini which empties into the lateral sinus.

Thrombosis of the central artery of the retina. See **Retinal arteries, Thrombosis of the.**

Thrombosis of the central retinal vein. See p. 1962, Vol. III of this *Encyclopedia*.

In addition to the matter there discussed it may be stated that according to a review of the subject from observations of 36 cases by George Coats (*Arch. f. Ophthal.,* p. 341, Vol. 86, 1914) the obstructions in the central vein are almost always caused by true *thrombosis*. Microscopically the thrombus may be visible as a homogeneous, structureless mass. More frequently an invasion of fibroblasts from the surrounding connective tissue or of secondary proliferation of endothelium are found, the final result of the changes. In most cases the essential cause of thrombosis seems to be retardation of circulation due to vascular sclerosis, especially endarteritis of the central artery. It may also be due to a primary inflammation of the vascular wall, especially in young persons, and caused, e. g., by syphilis, influenza, etc. Microscopically, a primary affection of the venous wall is rare. Fibrous degeneration and infiltration above the obstruction are frequent and must be considered as secondary changes. The obstruction always occurs at, or near, the lamina cribrosa. The vein very rarely remains collapsed and empty above the obstruction. In most cases the blood-current is soon restored by the collateral circulation, earlier if the central artery is relatively free from disease and the propelling force not weakened. In other cases the blood-current is restored by canalization of the thrombus. Immediately above the obstruction the vein is generally small and its wall slightly infiltrated, but not thickened. Farther upwards in the nerve trunk the fibrous tissue of the wall is thickened and infiltrated.

The retinal vessels show the following changes: fibrous proliferation, hyaline degeneration, proliferations of the endothelium, inflammatory infiltration of the walls, thrombosis, telcangiectasia. Of these, fibrous proliferation is the most frequent in both arteries and veins. The most frequent affection of the central artery is disease of the intima alone. Proliferation of the endothelium in the retinal vessels is relatively rare and is probably a reaction to irritation by the circulating toxin. Ophthalmoscopically, proliferations of the endothelium appear as irregularities of caliber, fibrous degenerations (silver-wire artery) and white lines along the vessels. It is doubtful whether the complete typical picture of retinal apoplexy ever occurs in obstruction of the retinal vein alone and the central vein remains free. Teleangiectasia of pre-existing vessels indicates a difference of pressure between two vessels or two portions of the same vessel. Al-

terations in the retinal vessels are partly primary, partly secondary; the primary are more frequent in the arteries, the secondary may also occur in the arteries, but are especially frequent in the veins.

Diseases of the ciliary vascular system associated with retinal vein obstruction are much rarer. Apparently the extent of retinal hemorrhages depends to a certain degree on the intensity of the endarteritis in the central artery. If this is lacking and the propelling force is not diminished, it is likely to be profuse.

Glaucoma, which frequently follows obstruction of the central vein, is a direct consequence and is not an independent affection due to angiosclerosis in the anterior segment of the eye. It does not show the type of primary glaucoma. The anterior chamber is generally of normal depth; a new formation of vessels at the surface of the iris is very common, and there are no distinct inflammatory symptoms. A vascular fibrous membrane is found at the surface of the iris, caused by deposits of inflammatory cells on the iris and in the sinus. Glaucoma is the consequence of closure of the efferent paths by these cells. According to Inouye this affection of the iris and sinus is caused by toxins, which are diffused from the disintegrated blood of the posterior segment of the eye through the vitreous to the iris, while the excretion of the toxins is impeded by the obstruction of the central vein. This is probably the reason why other forms of intra-ocular hemorrhages are rarely followed by glaucoma. This is also the reason why an interval of from three to four months occurs between the outbreak of glaucoma and the thrombosis.

Intense thrombosis of the central retinal veins with recovery of normal vision is reported by G. H. Mathewson (*Archives of Ophthal.*, Sept., 1911). A patient, 30 years of age, complained that he was almost blind in the right eye. While looking out of the window he suddenly noticed his loss of vision. Neither eye had previously been involved in any way. He had no pain in the eyeball nor has he had any since, blindness being the only symptom." The right leg was amputated at the junction of the middle and upper thirds of the thigh at the age of eight, for the relief of what was probably osteomyelitis. The stump was healthy. The circulatory system is normal, except that the radial artery is somewhat thickened. The temporal arteries are normal; the heart and urine are also normal. There is great swelling of the optic disc, five D., but one can see a deep, physiologic cup. There is extreme congestion and tortuosity of the veins, which tortuosity is in both the plane of the retina and at right angles to it. Where the arteries can be seen they are somewhat narrowed. There are multiple hemorrhages, nearly all flame-shaped, arranged in a stel-

late manner about the nerve as a center. There are also a number of hemorrhages about the peripheral part of the retina; two patches of exudate may also be seen. Vision in this eye is reduced to fingers 12 feet; vision in the left is normal. A blood count gave no light on the subject, while Calmette's tuberculin test in the eye showed no reaction. One month later the number of hemorrhages was reduced but edema of the retina was still definitely present. After disappearing from the clinic the patient returned almost one year later when vision in the right eye was found to be 6/vi. The fundus of this eye showed no abnormality beyond one or two slate-colored spots which were probably the site of the former hemorrhages."

S. H. Browning (*Oph. Review,* p. 84, March, 1912) reviews the essay of Valude (*Annales d'Oculistique,* Vol. 146, p. 426, 1911) on infective thrombosis of the central vein of the retina. The writer states that apart from arterio-sclerosis, syphilis and diseases such as diabetes and pernicious anemia, there are few recorded cases of *infective* thrombosis of the central vein of the retina. Knapp has described thrombosis in erysipelas, but there was also an orbital abscess; while Gorin published a case where the thrombosis accompanied phlebitis spreading from the orbit. He also suggests the same explanation in the case of cerebro-spinal meningitis published by Randolph in the *Ophthalmic Review* of 1893.

Michel's work was chiefly directed towards cases of thrombosis due to arterio-sclerosis.

The author thinks that there are cases in which the origin of the venous thrombosis ought to be traced to a general infection, and describes two cases.

1. A man of about 30 years of age complained of visual trouble in the left eye of recent date. About a fortnight before, after a severe headache on the left side, the patient suddenly had difficulty with his sight in the left eye, which had been neither red nor painful. The patient said that the sight in this eye had been excellent, and that he used it in shooting. The right eye was astigmatic and myopic. Urine normal. His vision rapidly became worse, until he could no longer distinguish objects clearly. For ten days it remained in this condition.

On examination of the left eye, the man could count fingers at two metres. The fundus showed the characteristic changes of retinal apoplexy due to thrombosis of the central vein. The fundus of the eye was scattered over with hemorrhagic spots, which radiated from the papilla, the optic disc had a diffuse margin, the edges were covered with hemorrhagic lines showing the distribution of the nerve bundles, the

veins were tortuous and filled with dark blood, while the arteries were hardly visible. Tension was normal.

Chauffard examined the man for his general condition, and found that he had had an acute gonococcal urethritis for a month, and attributed the thrombosis of the central vein of the retina of the left eye to the gonococcal infection.

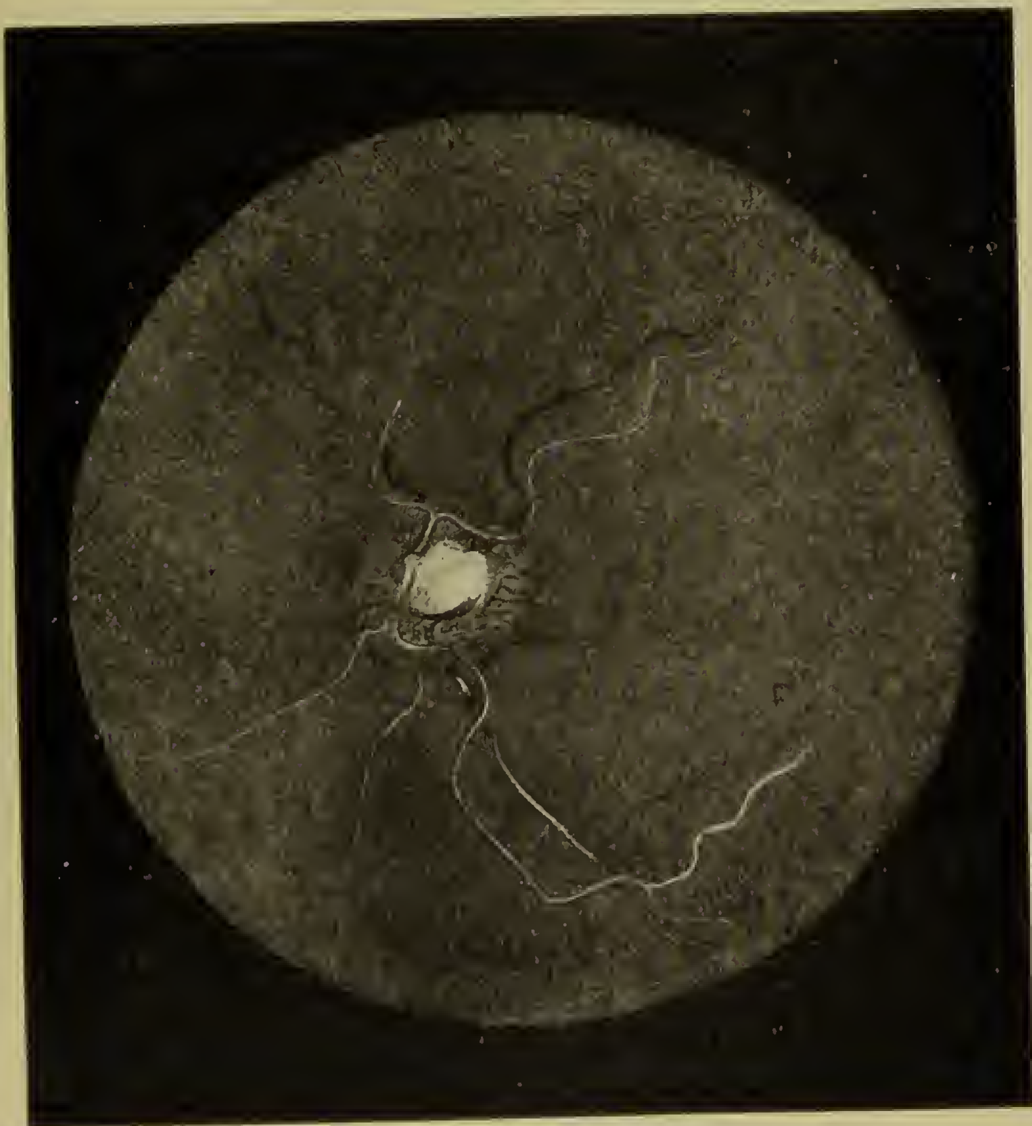
Fundus Appearances of a case of Retinal Venous Thrombosis with extensive Hemorrhages (Reber).

As regards prognosis the author states that when he saw the patient a month later there was great improvement in his vision,—2/10 to 3/10 in the left eye, the hemorrhage had almost disappeared, the region showed a single hemorrhagic spot, and the veins were swollen. Three weeks later vision was sufficiently good to allow him to read the paper.

Case 2. A woman 52 years of age, in good health and with normal urine, was stung by a wasp on the left arm. The arm became much swollen. At the same time she had a bad headache, localized upon the left side. In the evening the patient after sewing noticed a thick mist

before her left eye, which disappeared almost at once. The next morning the trouble reappeared, and became permanent. She could count fingers at three metres with the left eye. The fundus presented the same appearance as the first case.

The author considers this to be a case of infective thrombosis of the central vein, secondary to the inflammation in the arm.



Fundus View of a Case of Thrombosis Venarum Retinalium. (Reber.)

Taylor (*Oph. Year-Book*, p. 219, 1913) calls attention to those cases in which sudden impairment of vision is associated with thrombosis of the retinal venous branches, with the occurrence of hemorrhage and diffusion. Among 8 of these cases he found that 7 had either albuminuria or hypertrophied heart; some presenting both conditions, and only one case free from them. This last case continued in fair health after

two years; and Taylor has seen such a case in health six years after the occurrence of the thrombosis.

Cantonnet saw a woman who, three days before death from pyemia, was attacked in one eye with panophthalmitis, and in the other showed a large retinal hemorrhage. Reber reports a case of thrombosis of the central vein that he regards as secondary to nasal disturbance. The patient was a man of 45, otherwise healthy, and rhinologic treatment was followed by restoration of vision to 20/30. See the accompanying figure.

Ormond reports a case of thrombosis of the superior nasal branch of the central retinal veins in a boy of 12, who gave a positive tuberculin reaction. Lawford saw a man of 68 with a retinal hemorrhage hiding the superior temporal vessels. The vein was turgid and dark, but not tortuous. At the end of nine months the vein was white, and opaque from the periphery to where a large branch joined it 2 disc diameters from the papilla; but from there it appeared normal. The superior temporal artery showed thickened opaque walls through its whole length with a narrowed bloodstream a short distance from the disc. The other vessels were healthy in appearance.

Thrombosis of the ophthalmic vein. See p. 409, Vol. I of this *Encyclopedia*. Thrombosis of the ophthalmic vein is accompanied by pain, notably over the course of the supra-orbital vein and in the eyeball. The patient complains of varying degrees of headache, and, if the case is complicated with meningitis or brain-softening, cerebral symptoms are apparent.

Thrush in the eye. Aphthæ, the white spots on the buccal mucous membrane of infants, are due to the presence of the fungus *oidium albicans*. Occasionally the eye is attacked. See p. 8475, Vol. XI of this *Encyclopedia*.

Thune, Ludwig Georg Wilhelm. A Danish military physician, who devoted much attention to ophthalmology. Born at Copenhagen Oct. 3, 1803, he became a physician in 1828, and two years later an officer in the Danish army. In 1834 he received the medical degree at Halle. He continued to serve in the army, and to devote the major portion of his time to ophthalmology. In 1857 he was sent to the Ophthalmologic Congress. He died at Copenhagen Sept. 25, 1869.

His chief ophthalmologic writing was "Om Ophthalmia Ægytiaca (Belgica, Contagiosa) og Prof. Fr. Jaeger's Ausknelser af denne Sygdom" (*Jour. f. Med. og Chir.*, VII).—(T. H. S.)

Thurmschädel. (G.) That peculiar form of cranium known as "tower-skull" (q. v.).

Thyme. *Thymus serpyllum.* According to Pliny the elder, thyme, when

eaten as a food, was an excellent means of strengthening the sight.—(T. H. S.)

Thymodin. See **Aristol.**

Thymoform. A yellowish, antiseptic powder prepared from formaldehyd and thymol. It is soluble in ether, alcohol, chloroform and olive oil, but insoluble in water and glycerin. It is used in eye diseases like aristol and iodoform.

Thymol. A crystalline thyme camphor from the oil of thyme and other plants. It is an important antiseptic, used occasionally externally (in 1:1,000 solutions) in eye diseases.

F. P. Calhoun (*Journ. Am. Med. Assocn.*, p. 1078, Sept. 21, 1912) notes that toxic amblyopia from thymol has been observed by Farrel, of the North Carolina Hookworm Commission. He could not tell whether it was temporary or permanent. It had occurred twice in 28,000 cases and Nieden mentions amblyopia, temporary or permanent, from ½ to 2½ drams of extract of filicis maris (malefern).

Thymol iodide. See **Aristol.**

Thymotol. See **Aristol.**

Thymus gland, Ophthalmic relations of the. The thymus is a bilobar, ductless body found in the infantile neck and thorax. It is composed of an areolar tissue lobe inclosed in a capsule containing endothelial cells with leucocytes and corpuscles of Hassall. The thymus appears to be a true lymph gland and to have true hematopoietic functions. It begins to atrophy about the second year and disappears about the end of the thirteenth.

Frank R. Spencer (*Am. Journ. of Ophthalm.*, Oct., 1917) in speaking of the *rôle of the ductless glands in ophthalmology* says of *thymus hypersecretion* that its effects are in marked contrast with stimulation of the sympathetic by *thyroid* (q. v.) hypersecretion. Stimulation of the vagotonic or autonomic system by hypersecretion from the thymus produces contracted pupils, narrow palpebral apertures, esophoria, spasm of accommodation, deep ciliary congestion and chorioretinal and scleral disturbances of circulation.

Persistent hyperplasia of the thymus was found by Garre in 95 per cent. of fatal cases of exophthalmic goiter. Von Haberer obtained remarkable improvement in a patient whose condition was very serious following a thyroid operation, by removing part of the thymus. According to Halstead's recorded cases, thymus feeding, radium and Roentgen-ray treatment improved remarkably patients who had not been benefited by thyroidectomy and ligation of the thyroid arteries for exophthalmic goiter.

Lamb states that "the more chronic inflammations may usually arise

in conjunction with vagotonia, but such a condition as simple glaucoma is probably the end result of gonadal and adrenal insufficiency. Whereas acute inflammatory glaucoma is probably the result of a sudden imperative demand upon the adrenals for secretion to sustain the body in its attempt to defend itself against shock, fear, etc., in the presence of gonadal and adrenal insufficiency; for, although the secretion is forthcoming for a short period, the inability to continue to supply it causes a precipitate lowering of sympathetic tone and throws the balance under the control of the vagus. This, of course, in the presence of predisposing factors, such as high hyperopic eyeballs and other anatomic abnormalities."

"This idea of the etiology is substantiated by the fact that pilocarpin and adrenalin, by hypodermic injection, overcome the attack; and, furthermore, stimulation to the sympathetic is well known to be always beneficial."

Thyroidectomy, Ophthalmic relations of. Hypothyroidism. Removal of a portion or all of the thyroid gland—as well as the methods and the indications for it—are discussed and illustrated on p. 4818, Vol. VI, *et seq.*, of this *Encyclopedia.*

It has long been known that extirpation of the gland is occasionally followed by untoward symptoms, some of which are indicated by the eye.

Walter Edmunds (*Ophthalmoscope*, June, 1916) reported on certain *eye affection following sixteen experimental thyroidectomies.*

In several cases a ground-glass appearance of the cornea, resembling syphilitic keratitis, was noted, often passing on to ulceration of the cornea, with more or less collapse of the eyeball.

The eye affection followed a complete excision of both thyroid and parathyroid glands, but to this there was one exception. The thyroid and parathyroid were excised on one side only, and the thyroid lobe and its parathyroid on the other side left intact, except for the excision of a considerable length of the nerves supplying them. In these animals a greatly higher proportion of eye complications occurred than with the simple total excision operations, and therefore it was inferred that the altered secretion of the thyroid and parathyroids produced by interference with their nerve supply is more inimical to the nutriment of the cornea than the toxins produced by complete excision of the glands.

Zentmayer (*Journ. Am. Med. Assocn.*, July 7, 1917) points out that Gley and Rochon Duvigneaud found, from experiments on dogs, that in some instances after *extirpation of the thyroid gland* the cornea became porcelain white, leading at times to ectasia and superficial ul-

ceration. Microscopically leukocytic infiltration was found. Leber, nevertheless, suggests that the appearances indicate, as the cause, a toxic endothelial necrosis. These investigators also saw produced an acute blepharitis with abundant lachrymation. Halstead noted conjunctivitis, and as a further complication partial blindness without ophthalmoscopic changes.

Papilledema due to thyroidectomy. Krauss has reported a case of papilledema in a man, aged 23, coming on after thyroidectomy and first observed eight weeks after the operation. Although the parathyroids had been carefully avoided, the operation was followed by a toxemia inducing tetany. Central vision was about normal and the fields showed partial color reversal with peripheral transient scotomas; but the distinctive feature was said to be a slight reduction of the form field with abnormally large color fields. There were prodromal attacks of absolute blindness immediately after the operation. The retinal edema extended from the peripapillary region along the course of the vessels.

Cataract following thyroidectomy. After thyroidectomy in a woman, in which the operation was followed by tetany, Westphal saw double cataract going to maturity in five years; and Schiller observed bilateral cataract develop within six months after partial removal of a goiter in which the operation was followed by tetany.

The occurrence of tetany in all of these cases suggests an insult to the parathyroids as the probable essential factor in the post-operative symptoms.

The *influence of the parathyroids in the causation of senile cataract* has engaged the attention of Fischer and Triebenstein and also of Heschler; but the conflicting evidence prevents definite conclusions at this time. The former claim to have found signs of latent tetany in 82 per cent. of sixty-eight patients with senile cataract, whereas in control patients of the same age the percentage of tetany was less than 20. Heschler, however, found but 2 per cent. of tetany in fifty cases of presenile and senile cataract.

Thyroid extract. GLANDULÆ THYROIDEÆ SICCÆ. DESICCATED THYROID GLANDS. THYROIDIN. This remedial agent consists of the thyroid glands of the sheep freed from fat, cleansed, dried, and powdered. One part of the powder represents 5 parts of the fresh glands freed from fat. It contains iodine organically combined with other active agents. Dose, 0.12-0.6 gm., 2-10 gr.

In addition to the employment of this remedial agent in the internal treatment of exophthalmic goitre, *(q. v.)* it is considered by Radcliffe *(Prac. Med. Series Eye*, p. 70, 1909) to be of particular value in the

various forms of keratitis. He advocated in a recent paper its use in these affections, commencing with a small dose, one or two grains three times daily, watching carefully the constitutional effect. He believes it to be of great advantage to use it early and even in cases where other drugs are properly indicated. While the physiological action of thyroid is not fully understood, he believes it has a dual action; first, on the lymphatic system and, secondly, in increasing metabolism and nutrition. It undoubtedly increases the lymphatic action, as a marked improvement was seen in his cases within the first four days beginning its use. Such rapid improvement would hardly be the result of an improved nutrition alone.

Jas. Bordley Jr. (*Pres. Reprint Sec. Ophthalm., Am. Med. Assocn.*, p. 273, 1916) has reported on eight cases two additional to those previously described of malignant uveitis as evidence to support the idea of the value of thyroid extract (iodothyrin in doses of 2½ grains) in malignant uveitis. Four of the cases, so far as can be determined by examination, are well. He emphasizes again in malignant uveitis we have to deal with two factors: an infection, and an eye that makes a strong defensive, but lacks the something necessary to an offensive fight. In every one of the five cases cited, a focus of infection outside of the eye was discovered. While it is proper, he says, that we should bend our efforts to the discovery of the source of infection, it must be remembered that the mere finding of a focus is not proof of its causative relation. Nor should we forget that malignant uveitis once established becomes an entity and not a symptom. We can remove the original source of infection and still not materially lessen the progress of the ocular changes. We cannot anticipate and often cannot discover secondary foci which may play an important part in the degenerative process. It, therefore, becomes necessary for us to fortify the eye against invasion, and to promote a strong offensive effort on its part.

Having observed the profound changes which frequently occur in the thyroid gland following severe infections, such as tonsillitis, peritonitis and skin burns, he is prepared to believe that the thyroid gland plays an important part in the body's fight against infection or the results of infection.

Percy Dunn (*Br. Journ. of Ophthalmology*, p. 11, Jan., 1919) offers an enthusiastic plea for thyroid therapy in many eye diseases and concludes by quoting Hertoghe who claims that "All the great causes of pathological disturbance, tuberculosis, syphilis, alcoholism, paludism, chronic starvation, consanguinity, etc., aim their first blow at the thyroid." The admission, therefore, says Dunn, is unavoidable that

thyroid therapy cannot be regarded as a "fad," liable at any time to be cast aside as a discredited fashion. Every day additional knowledge is being gained of its beneficent reality, and no one in these days can afford to neglect its teaching. Hertoghe's forecast, therefore, that "The day is coming when we will interrogate the thyroid equation (hypo- or hyper-) in all our patients with the same fidelity that we inquire into their previous history, in respect to tuberculosis, syphilis, and alcoholism," may come to be realized in practice. The old common saying "a man is as old as his arteries" is sadly out of date. Its misconception lies in its recognition of effects rather than of causes. A truer axiom would be "a man is as old as his thyroid," for it is the thyroid, as the regulator of nutrition, which keeps an old man, with vigour of mind and body, young, by counteracting auto-intoxication —Metchnikoff's theory of the cause of old age. It is the thyroid, too, which prevents and controls the advent and progress of arteriosclerosis. Oftentimes dulness of spirit and a disturbing melancholy, irrepressible by volitional effort, are of toxemic, and not of psychological origin: in such cases by stimulating a tired thyroid, the buoyancy of life is restored, and the mist-clouds of despondency dispersed.

Thyroidin amblyopia. Myles Standish (*Trans. Am. Ophthalm. Soc.*, Vol. 14, part ii, p. 608, 1916; review in *Ophthalmology,* p. 656, Dec., 1916) emphasizes the fact that the administration of thyroid is not altogether devoid of danger as regards the eye, and must, in fact, be added to the already long list of substances capable of causing retrobulbar neuritis.

Standish has been able to collect from the literature eight cases where the existence of central scotoma or optic neuritis has been attributed to the administration of thyroid, either in medicinal form or under the guise of some one or other of the widely-advertised *anti-fat nostrums.* Of the eight cases brought together by Standish, no fewer than five were reported by Henri Coppez (*Archives d'Ophtal.*, 1900), while C. R. Hennicke (*Klin. Monatsbl. für Augenheilk.*, 1911), E. Snydacher (*Journal American Medical Association,* October 28th. 1911). and Aalbertsberg (*Weekbl. van het Ned. Tijdschr. voor Geneesk.*, Vol. II, No. 22), are responsible for one each.

To these Standish now adds a history of three cases: 1. Woman, aged 69 years, affected with a small central scotoma in the left eye and a central scotoma for green in the right eye. R.V. 6/30. L.V. 6/25. Slight swelling the right optic disc, together with some narrowing of the retinal arteries, but no pronounced turgescence of the veins. A case of myxedema. For fourteen years had taken a five grain tablet of thyroidin three times a day, and for five or six years, one a day. The

thyroid was discontinued, and vision improved. The patient died suddenly some ten weeks after she was first seen by Standish.

2. A man, aged 41 years, whose thyroid gland had been removed, on account of a fibrous tumor, about two years before, had taken a one-half grain tablet of thyroidin before each meal. R.V. 1/10. L.V. 8/10. Central scotoma in the right eye for all colors, except dark blue. Limits of the field for white normal as regards that eye. The optic discs were of normal color, and the retinal vessels were not markedly changed. A few months after omitting the thyroidin, vision became normal.

3. A well-nourished lady, aged 33 years, complained of sudden loss of vision. With the idea of reducing her weight, she had taken for five days a proprietary medicine, believed to contain as its main ingredient desiccated thyroid. Sight failed after she had taken this preparation for three days. V. 20/200. Both optic discs pale, and retinal arteries small. Central scotoma for all colors. The nostrum was discontinued, and thirty-four days later, R.V. 20/40 and L.V. 20/70. The optic discs, however, remained somewhat whiter than normal.

Thyroid gland, Ophthalmic relations of the. HYPERTHYROIDISM. PARATHYROIDISM. This section should be read in conjunction with **Myxedema,** p. 8278, Vol. XI; **Acromegaly; Cretinism; Exophthalmic goitre** (especially p. 4821, Vol. V) and **Basedow's disease.**

The thyroid is a large, reddish ductless gland situated in front of and on either side of the trachea. It consists of two lobes and a connecting isthmus and is enclosed in a connective tissue capsule containing colloid material. It is made up of many closed follicles surrounded by a vascular network. The thyroid is probably a true hematopoietic organ and performs functions of the greatest value in the human economy. The colloid matter just referred to is composed of a protein and a non-protein constituent, together with iodin, phosphorus, a nucleo-albumin and certain extractive compounds. See, also, **Thyroid extract.**

The *accessory thyroid* is a detached portion of the gland, occasionally present at the base of the tongue. There are sometimes two of these bodies, and they are quite distinct from the four *parathyroid bodies.*

Zentmayer (*Journ. Am. Med. Assocn.*, p. 1, July 7, 1917) in his essay on the eye and the endocrine organs says that the close topographic *relations of the thyroid to the parathyroid* and sympathetic system make it difficult both in human surgery and in animal experimentation in operating on one structure to keep the other inviolate, and it is therefore difficult to decide in what relative degree the in-

volvement of these structures is responsible for the resulting symptoms.

AFFECTIONS OF THE THYROID.

Exophthalmic goiter. In view of the fact that some of the gravest symptoms of this affection may exist in the absence of either or even both of the phenomena from which it has received its most commonly given name, and that its pathogenesis is now known, it would seem more appropriate to speak always of this syndrome as "hyperthyroidism."

In the majority of the cases of hyperthyroidism, at some period, the eye symptoms, says Zentmayer, dominate the clinical picture. The retraction of the upper lid, to which the striking and pathetic facies is due, is often the symptom which first calls attention to the existence of the disease. Associated with this we usually find loss of coordination between the downward movement of the globe and the upper lid, and occasionally difficulty of eversion of the upper lid, and Kocher has observed that when an object fixed by the eye is moved rapidly up and down, it causes a convulsive momentary contraction of the upper lid, while Joffroy has noted a failure of the skin of the forehead to wrinkle when the patient looks up.

Under the term "deficient complementary fixation in lateral eye rotation," Suker has recently described an ocular symptom of hyperthyroidism. After extreme lateral rotation of the eyes either to the right or to the left with the head fixed and with fixation of an object at this point maintained for a second or two, on attempting to follow this fixation point as it is rapidly swung into the median line, one of the eyes—it may be either—fails to follow the other in a complementary manner into proper convergence and for this point when it is brought into the median plane. Either the right or the left eye makes a sudden rotation into the fixation with its fellow, but before it does so, an apparent divergent strabismus is manifested. According to Suker, it is no doubt due to a dissociation in the functions of the sympathetic and the extraocular motor nerves of the eye, and perhaps also to exhaustion on extreme lateral rotation of the eyes. See **Exophthalmic goitre.**

Myxedema. In this condition, continues Zentmayer, in which the changes in the thyroid are chiefly atrophic, the edema of the eyelids with the consequent narrowing of the palpebral fissures is the most marked ocular phenomenon. The edges of the eyelids are hyperemic; the eyebrows are elevated and the hairs and cilia are sparse and brittle. Subconjunctival hemorrhages may occur. Other symptoms are lachry-

mation, asthenopia, neuroretinitis (Wagner) and superior-temporal contraction of the visual field (Ottolenghi).

Petzetakis studied the oculocardiac reflex in six persons with myxedema and found it enormously intensified over what is observed in normal persons. He believes that the hypothyroidism leaves the sympathetic without the normal stimulation of the thyroid, and as a consequence vagotonus results. In one case the normal balance was restored by thyroid feeding. See **Myxedema.**

Cretinism. In this condition, which has been called infantile or juvenile myxedema, besides the conditions just enumerated, there is a wide spacing of the eyes. A conjunctivitis which is sometimes present has been attributed by Hitschmann to the interference with drainage, the result of the saddle bridge.

In both of the foregoing conditions it has been noted that the mydriatic effect of homatropin and similar drugs persists beyond the usual time. See p. 3558, Vol. V of this *Encyclopedia.*

Mongolian idiocy. Because of a slight outward resemblance to the foregoing two affections and because of the improvement resulting from the use of thyroid extract, some modern clinicians suspect a thyroid origin for the Mongolian type of idiocy, in which the eye symptoms of epicanthus and convergence of the palpebral fissures have originated the terminology of this affection. See p. 6138, Vol. VIII of this *Encyclopedia.* See also **Thyroidectomy.**

Hypothyroidism and optic atrophy. The possibility of hypothyroidism producing optic neuritis terminating in atrophy is indicated by the occurrence of consecutive atrophy in two brothers and a sister who with other members of the family had general symptoms of hypothyroidism in a case reported by van Lint and Klesfeld. The visual fields showed peripheral contraction without scotoma. The roentgenograms revealed no lesions of the sella turcica.

Parathyroids. There is some experimental evidence to indicate that disturbed function of the parathyroids alone can cause cataract. While the experiments of Erdheim showing that in parathyroidectomized animals there is a diminished calcification of the dentin and a hyperplasia of the enamel which frequently leads to fracture of the teeth, and those of MacCallum, Voegtlein, Leopold and von Reusz, which demonstrated a decrease in the lime secretion and a diminution of the bone salts, do not have a direct bearing on established relationship between the parathyroids and the eye, they do direct one's thoughts to the possible bearing of these findings on the syndrome of blue scleras and friability of the bones.

The view of Jeandelize that many convulsive disorders of man

(convulsions of childhood, epilepsy and eclampsia) are due to parathyroid insufficiency, together with the experimental evidence adduced, strengthens the assumption that relative insufficiency of the secretion of these glands is an important factor in the etiology of zonular cataract.

Thyroidin. See **Thyroid extract.**

Thyroncus. Same as goiter.

Thyson of Hermione. A classical patient, whose votive-tablet placed in the temple of Asklepios at Epidaurus about 300 B. C., is still extant. The tablet reads: "The Blind Boy, Thyson of Hermione. This boy, while dreaming, was licked on the eyes by one of the hounds of the temple, and went home cured."

For temple-sleep as a means of treatment among the ancient Greeks, see **History of ophthalmology.**—(T. H. S.)

Tic. 1. As formerly used, any spasmodic movement or twitching, as of the face. 2. As at present used, a psychoneurosis marked by quick, sudden spasms that are identical with the movements of volitional intent. Tics occur in persons of neurotic tendency, are often hereditary, and usually develop in youth. Called also *mimic spasm, habit-spasm,* and *maladie des tics.* See **Blepharospasm,** p. 1112, Vol. II of this *Encyclopedia;* also **Facial tic.**

Tic douloureux. A spasmodic facial neuralgia. See **Neuralgia of the fifth nerve; Facial tic,** p. 5139, Vol. VII, as well as the same subhead under **Neurology of the eye,** in this *Encyclopedia.*

Tic, Facial. See **Facial tic.**

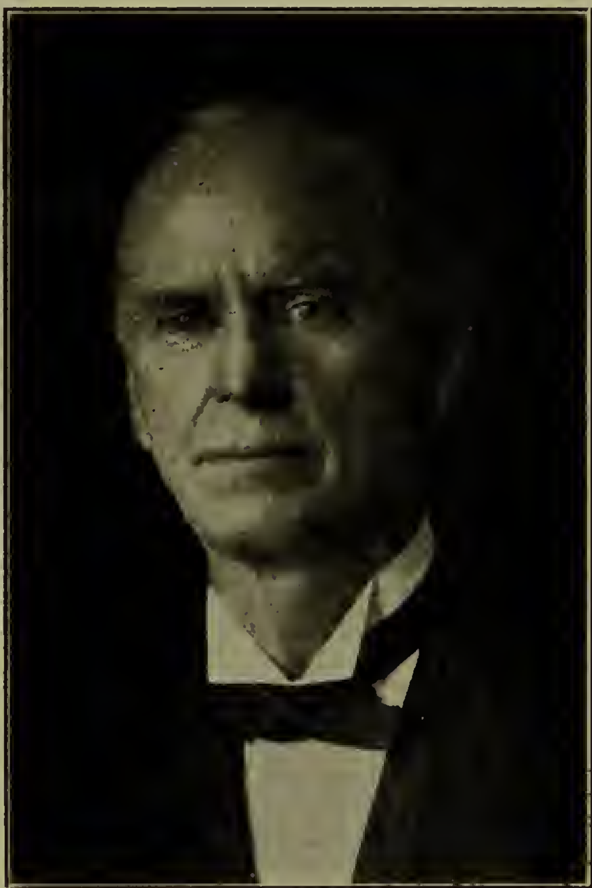
Tick, Dog. This is an acarus-like arachnid *(Ixodes ricinus)* really dwelling on various plants but infesting also dogs, man, etc. G. F. Cosmettatos (*La Clinique Ophthalm.,* Nov. 10, 1912) describes the microscopic appearances of a conjunctival cyst which was caused by the remains of a dog-tick. The head and feet were found, the rest of the animal having been removed by the patient himself. Microscopic appearances showed that it was a serous cyst of the conjunctiva.

Tiffany, Flavel Benjamin. A well known ophthalmologist of Kansas City, Mo. Born at Cicero, Oneida Co., N. Y., April 28, 1846, son of Ambrose and Electa Shepard Tiffany, he early moved with his parents to Rutland, Dane Co., Wisconsin, and afterward to Baraboo. The following year he moved again, to Rice Lake, Minn., where his mother died. The Civil War breaking out, he enlisted at the age of seventeen in Battery B, Fourth Minnesota Light Artillery, and served until the close of the strife. Returning to Minnesota, he went to school at Faribault, living with a Dr. Bemis, and doing manual labor for his board. Before he was twenty years of age he entered the State Uni-

versity at Minneapolis, but could not quite complete the literary course because of failing health, the result of over-work and great privations.

In 1872 he entered the Medical Department of the State University at Ann Arbor, Mich., receiving the degree in 1874.

He settled at first in Grand Haven, Mich., but, being unsuccessful, went again to Minnesota, thence to East St. Louis, where, however, he was once again unsuccessful. Returning once more to Minnesota,



Flavel Benjamin Tiffany.

he was ably assisted by a worthy and wealthy lady, Mrs. Esther Fuller, and, settling at Medford, soon had a very large practice.

In 1876-'7 he studied the eye, ear, nose and throat at London, Berlin, Vienna, and Paris, in the latter city meeting Miss Olive E. Fairbanks, whom he afterwards married in Kansas City, Mo., 1879.

In 1878 he settled as ophthalmologist and oto-laryngologist at Kansas City, Mo., and soon was widely known as a lecturer and operator. In 1880 he founded the Kansas City University, in which institution he held the chair of ophthalmology, otology and microscopy until 1893. The chair of ophthalmology and laryngology he continued to hold until

about the time of his death. For many years he was president of the institution.

Dr. Tiffany was oculist to the Burlington and the Missouri, Kansas and Texas railways. He was a fellow of the American Medical Association, the Mississippi Valley Medical Association, Missouri Valley Medical Association, and the Tri-State Medical Association. He was president once of each of the two last mentioned institutions. He was also a member of the City Club, of the Knife and Fork Club, was a Republican, and an active member of the Episcopal church.

Dr. Tiffany was a small, spare man, smooth-faced, of fair complexion and with blue eyes and brown hair. He was brisk, alert, frank and friendly. Fond of travel, he made the "grand tour" twice, and sixteen separate trips to Europe. He liked music and was greatly interested in the French language and people.

Dr. Tiffany's first wife died in 1910. On September 12, 1912, he married Miss Zoe Clark, at "Tiffany Castle," his residence at Garfield Avenue and Cliff Drive. The couple left at once for a trip around the world, described in his latest volume, *"Journey Round the World by an Oculist."* Of this union were born two children, Flavel B. and Mary Louise.

Dr. Tiffany died at St. Luke's Hospital, Kansas City, Mo., Jan. 4, 1918, of arterio-sclerosis. He was survived by his wife and children.

Doctor Tiffany wrote numerous books and articles, the most important of the former being, *"Anomalies of Refraction and Diseases of the Eye"*; *"A Sojourn in Switzerland"*; *"A Sojourn in Spain,"* etc. The more important journal articles deal with cataract and glaucoma.—(T. H. S.)

Tiger retina. The fundus in chronic retinitis pigmentosa (q. v.).

Tige sus-sphénöidale. (F.) The hypophysis cerebri.

Tigroid. Spotted like a tiger. A term applied to Nissl bodies or masses of deeply-staining substance in the protoplasm of neurons.

Till. *Sesamum orientale.* The same as sesame. In ancient Greco-Roman times, till, boiled in wine, was often employed as a poultice to the eyes or forehead in any acute affection of the eyes.—(T. H. S.)

Tilley, Robert. A well-known Chicago ophthalmologist. Born in England, he came to America when a mere lad. His medical degree was received at the Chicago Medical College in 1876. He was ophthalmologist to St. Luke's Hospital. One morning in June, 1898, he was found dead in his bed at the Lexington Hotel, Chicago.—(T. H. S.)

Tilting, Head. A habit indulged in by patients suffering from oculomuscular defects—especially from hyperphoria.

Timidus. (L.) An old term for the inferior rectus muscle.

Timoleon. A great Corinthian general, who flourished in the 4th century B. C., and who, in his later years, became totally blind. He was a son of Timodemus, or Timænetus and Demeristé. When merely a youth he slew his own brother, Timophanes, who was endeavoring to make himself tyrant of Corinth. This extreme love of liberty, in fact, was characteristic of Timoleon throughout his entire life. In B. C. 344, at the request of certain of her daughter towns in Sicily, Corinth despatched Timoleon with a handful of soldiers to expel therefrom a horde of Carthaginian invaders. Immense reinforcements arrived very shortly from Carthage, but, in spite of the desperate odds, Timoleon conquered his enemies, and, in 338, concluded with them a highly satisfactory treaty. But the great military leader and advocate of liberty did not stop with this. He continued his efforts in the cause of freedom until he had deposed practically all the tyrants from the Greek cities in Sicily.

Late in life Timoleon became blind. The story of his blindness is narrated by Plutarch as follows: "* * * began, as he was now growing old, to find his eyes fail, and awhile after became perfectly blind. Not that he had done anything himself which might occasion this defect, or was deprived of his sight by any outrage of fortune; it seems rather to have been some inbred and hereditary weakness that was founded in natural causes, which by length of time came to discover itself. For it is said that several of his kindred and family were subject to the like gradual decay, and lost all use of their eyes, as he did, in their declining years. Athanis the historian tells us that even during the war against Hippo and Mamercus, while he was in his camp at Mylæ, there appeared within his eye a white speck, from which appearance all could see the terrible calamity that threatened him. However, this did not hinder him from continuing the siege and prosecuting the war * * *"

Even after he had become very aged, the blind Timoleon was shown the greatest possible honors, and was always conferred with on every important occasion. Says Plutarch: "He was, on these occasions, carried through the agora on a litter, and brought in, sitting, into the theatre. There the people, with a single voice, saluted him by his name. Then, having returned the curtesy, as well as paused for a time till the noise of their blessing and high felicitations had begun to diminish, he listened to the business in question, and then delivered his opinion."

After his death he was accorded high honors. Thus, again according to Plutarch, "Demetrius, one of the loudest criers, proceeded to read this proclamation: 'The people of Syracuse have made a special

decree to inter Timoleon, the son of Timodemus, the Corinthian, at the common expense of two hundred minas, and to honor his memory forever, by the establishment of annual prizes to be competed for in music, and horseraces, and all sorts of bodily exercise; and this, because he suppressed the tyrants, overthrew the barbarians, replenished the principal cities, that were desolate, with new inhabitants, and then restored to the Sicilian Greeks the right to be governed by their own laws.'' He was also given a splendid tomb, surrounded by porticoes and many places of exercise, and this they called the ''Timoleonteum.'' Moreover, they held to the laws of Timoleon for many long years, both for the reason that these laws themselves were excellent and also because of a desire to honor the man who had framed them.—(T. H. S.)

Tinctura opii crocata. See **Crocus,** p. 3567, Vol. V of this *Encyclopedia.*

Tinctura opii deodorata. This mixture is made from opium, benzoin, alcohol and water, and contains 1.25 grains of morphia in each 10 cc. It is said to be preferable for internal use to the ordinary tinct. opii and is, presumably, superior to laudanum for instillations into the conjunctival sac. Since, however, the topical effects of morphia upon the ocular apparatus are at least doubtful we may ascribe any therapeutic action of liquid opium extracts to the alcohol they contain. (See **Opium.**) This tincture forms part of Scott's mixture (q. v.).

Tincture of iodine. See **Iodine.**

Tinea ciliaris. Ringworm of the lid.

Tinea tarsi. See **Blepharitis marginalis,** p. 1028, Vol. II of this *Encyclopedia.*

Tinea tonsurans. Ringworm is caused by the *trichophyton tonsurans.* When it attacks the eyebrows it produces its characteristic changes in the hair follicles. Gray, elevated patches are formed, and these are covered with yellow scales and dry, fragile hairs. The best treatment is epilation, followed by thorough washing with hydrogen peroxid and the application of a sublimate ointment—1:3000.

Tinted lenses. See **Colored glasses,** p. 2388, Vol. IV of this *Encyclopedia.*

Tinter. A slide of plain colored glass used in the production of moonlight or sunlight effects, or the like, by the magic lantern.

Tintometer. An apparatus for determining shades of color by comparison with standard tints.

Lovibond's tintometer is the best known. The Editor (*Medicine*, March, 1896) made a study of this instrument. It consists of two tubes (mounted within a box) at the terminals of which are placed the

object for comparison and the standard colored glasses with which the specimen under inspection is to be matched. It is remarkable how closely the composition of water, beer, and other fluids—not to mention all sorts of solids—can be calculated by noting their exact color value. See, also, p. 2478, Vol. IV of this *Encyclopedia*.

Tiodine. This is the name given by Weiss (*Wien. med. Wochenschr.*, 7, 1907) to a combination of thiosinamin with ethyl iodid. The iodine content amounts to 46.49 per cent. It forms white crystals, which are readily soluble in water, but with difficulty in alcohol.

Tiodine may be used by subcutaneous, intramuscular or intravenous injection, also internally in pill form. It is rapidly absorbed, has no irritant effects, the injections are painless, and the stomach is not disturbed. For hypodermic injection, 1 c. c. of a 10 per cent. solution is employed: in the interval two pills of 0.1 gm. may be daily administered. The indications for tiodine include all cases where cicatrization is present and thiosinamin is indicated. Tiodine is dispensed in ampullæ and pills.

Tipping of images. The displacement of the visual images in oculomuscular defects. See **Ophthalmoplegia.**

Tisi del bulbo. (It.) Phthisis bulbi.

Tithonic. Actinic.

Tithonographic. Photographic; impressed by the tithonic rays of light.

Tithonometer. Actinometer. An instrument for measuring the intensity of the sun's rays and of radiation by means of its photochemical effect.

Toad (Bufo). A genus of amphibians, typical of the family *Bufonidæ*. Toads are distinguished from frogs by the absence of teeth, by the roughness of the skin, by peculiarities in the breastbone, by the shorter hind-legs and by the dilation of the transverse processes of the vertebræ.

The common toad is a shy, nocturnal animal, hiding during the day in dark, damp places, crawling about at night in search of insects, grubs, slugs, worms and the like. Its appearance is familiar—a dirty brownish-gray color, a warty skin, a flat head, swollen parotid glands above the ears, bright jewel-like eyes with a transverse pupil, slightly webbed toes.—*(Standard Encyclopedia.)*

Toad poison may affect the eyes. Under the name of phrynin, bufonin, and bufidin a poisonous alkaloid, extracted from the venom of the animal, has been found to resemble digitalin in its action.

Tobacco. This well-known plant has for centuries been chewed, snuffed, smoked and otherwise ingested as a stimulant and narcotic. As commonly found it appears as the dried and prepared leaves of

Nicotiana tabacum. Tobacco contains a varying amount of nicotine and presents the qualities of a sedative, narcotic, emetic, diuretic, antispasmodic and heart depressant. It has been much used in medicine; rarely in ophthalmic practice.

In addition to the matter found under **Toxic amblyopia** (see, also, p. 303, Vol. I of this *Encyclopedia*) the *oculotoxic effects* of the plant and its derivations will be to some extent discussed here.

Kahn (*Oph. Year-Book*, p. 249, 1909) has found that the tobacco smoke from cigarettes contains 82 per cent. nicotin, and that from cigars from 85 to 97 per cent. There were in addition pyridin, ammonia, hydrocyanic acid, hydrogen sulphide, carbonic oxide and carbonic acid. He claimed to show that of all these substances nicotin was the only one to which a toxic action could be ascribed. He examined also nicotin free substances (Spanish reed, chestnut leaves, etc.) which occasionally give rise in children, who smoke them, to symptoms like those of nicotin poisoning. Only in the chestnut leaves was he able to find an alkaloid which had the same properties as nicotin.

Tobacco amblyopia was first described by Beer (1817). Women addicted to tobacco may show amblyopia and it may also occur in the absence of alcohol. In England the sufferers usually smoke "shag" but the ordinary tobacco mixtures may also cause amblyopia; less frequently cigars, and very rarely cigarettes. The condition may be caused by, and kept up by, tobacco chewing. The age at which it develops varies from 26 to 74. In the early stage the ophthalmological findings are negative, or at the most a slight blurring of the edges and discoloration of the disc. Later temporal pallor occurs, which in aggravated cases may assume the appearance of a complete atrophy. Amblyopia is produced in horses feeding upon certain plants, notably the *Nicotiana suaveolans* in Australia. The Virginia deer, however, eats the leaves of the tobacco plant without detriment, having become immune to its influence. The nicotin content of tobaccos varies from 2 to 8 per cent. Nicotin is an extremely potent poison, but it is only slightly volatile, while other equally strong poisons more highly volatile, are found in tobacco in small quantities, such as pyridin, and its derivatives picolin, lutidin and collidin. From the experimental work done, it would seem that toxic amblyopia is due to the action of the poison upon the synapses (branching fibres of the preganglionic fibres) either of the cone fibres or of the cone bipolars, or both.

The special selection by the toxin of the papillo-macular system and the macula may be vascular in its origin.

For treatment of tobacco amblyopia, see p. 301, Vol. I; as well as under **Toxic amblyopia** of this *Encyclopedia*.

Tobacco, English. An old name for the genus *Hyoscyamus*.

Tobacco, Poison-. Hyoscyamus niger.

Tobit. A celebrated blind man, chief character in the apochryphal work called *"Tobit."* First, let us speak about the book itself, then about Tobit and his history. The book of Tobit exists in Greek (two recensions), Latin (again two), Syriac, and Hebrew texts. Of these,

Tobias and the Archangels. (Botticelli.)

The son carries the fish whose entrails are to restore the lost eyesight of his afflicted father, Tobit.

one of the Greek texts is the oldest, and one of the Latin the most important—because the fullest, and, apparently, the most correct. All the texts are supposed to have been derived from one single written original. As early as Luther the book was regarded simply as a fable, or moral fiction. Luther, however, had an enormous admiration for this work. "What we have said of Judith" (yet another apochryphal book) "may be equally applied," he says, "to Tobias. If it be a history, it is a fine holy history; if it be a fiction, it is a fine holy fiction." Again he calls Tobit "a fine, pleasant, devout comedy."

The man, Tobit, and his history are certainly very interesting and instructive, and have even formed the subject of several celebrated paintings. The name, Tobit, we may say in passing, means, in the Hebrew, simply "my goodness." Tobit was a very pious Jew of the tribe and city of Naphtali, in Galilee, who, upon the conquest of Samaria by the Assyrian Shalmaneser (or "Enemessar") was carried away captive to the Assyrian capital, Nineveh. Here he became chief purveyor to the court of the King, and, waxing rich, was able to be of the utmost assistance to many of his less fortunate compatriots who also were captive in Assyria. At this time, with the usual foresight of a Jew, he deposited ten talents of silver with his kinsman, Gabael, who lived at Rages, in Media.

On the death of Shalmaneser, Sennacherib came to the throne, and then the excellent good fortune and prosperity of Tobit ceased. For Sennacherib, hearing that Tobit had given burial to certain Jews whom the King had caused to be put to death, stretched forth his hand to capture the alleged wrong-doer. But Tobit fled, and hid away both himself, his wife Anna, and his son Tobias. All his property which existed in Assyria was confiscated. On the death of Sennacherib and the accession of Esarhaddon, Tobit was allowed to return to Nineveh, but his property, as it seems, was not restored to him, and, because of his repeated burials of executed compatriots, he remained, in fact, little better than an outlaw. At this distressing period of his life it was that Tobit became blind.

The words of the book itself, in its authorized version, about the blinding of this holy man, run as follows: "Now when I was come home again, and my wife Anna was restored unto me, with my son Tobias, in the feast of Pentecost, which is the holy feast of the seven weeks, there was a good dinner prepared me, in the which I sat down to eat.

"And when I saw abundance of meat, I said to my son, Go and bring what poor man soever thou shalt find out of our brethren, who is mindful of the Lord; and lo, I tarry for thee.

"But he came again, and said, Father, one of our nation is strangled, and is cast out in the market-place.

"Then before I had tasted of any meat, I started up, and took him into a room until the going down of the sun.

"Then I returned, and washed myself, and ate my meat in heaviness,

"Remembering that prophesy of Amos, as he said, Your feasts shall be turned into mourning, and all your mirth into lamentation.

"Therefore I wept: and after the going down of the sun I went and made a grave, and buried him.

"But my neighbors mocked me, and said, This man is not yet afraid to be put to death for this matter: who fled away; and yet lo, he burieth the dead again.

"The same night also I returned from the burial, and slept by the wall of my court-yard, being polluted, and my face was uncovered.

"And I knew not that there were sparrows in the wall, and mine eyes being open, the sparrows muted warm dung into mine eyes, and a whiteness came in mine eyes, and I went to the physicians, but they helped me not: moreover, Achiacharus [his nephew] did nourish me, until I went into Elymais."

From this time on Tobit was supported, as it seems, partly by Achiacharus and partly by Tobit's wife, Anna, who "did take women's works to do." Once, on being paid for her "works," Anna was given a kid by her employers. The blind husband, believing that his wife had stolen the kid, told her plainly so and berated her roundly. Thereupon, Anna, in great bitterness replied, "Where are thine alms and thy righteous deeds? Behold thou and all thy works are known." Thereupon Tobit prayed—whence, later, the miracle whereby his vision was restored to him.

Now, on the same day whereupon Tobit prayed, it happened that, in Ecbatana, Sara, his kinswoman, the only daughter of Raguel, was likewise suffering unmerited and tormenting reproaches. For seven young men who had, successively, wedded her, had perished, each upon his very wedding night, by the hands of the demon Asmodeus, which is the devil. On the death of the last husband, one of Sara's female slaves, as well as certain others of her father's household, declared that their mistress was in fact seven times guilty of murder. At this, the innocent woman, in bitterness of heart, prayed to God that she might either die or that her honor should be vindicated.

The prayers of both these Jewish relatives, as the sequel will show, were abundantly answered.

Meantime, Tobit remembered the ten talents of silver which, in his prosperous days, as purveyor to Shalmaneser, he had lent to Gabael of Rages in Media. Just why Tobit had not earlier bethought him of this money, does not appear. But, at all events, he sent forth at this time his son Tobias to Rages of Media in order to collect the moneys which were due. Then the angel Raphael, being sent of the Lord to answer the prayers of Tobit and Sara, appeared unto Tobias under the form of his kinsman Azarias, and offered himself as a guide on the journey to Media. When, upon this journey, they had reached the Tigris River, behold there leaped up out of the river a great fish which would surely have devoured Tobias utterly. "Then the angel

said unto him, Take the fish. And the young man laid hold of the fish, and drew it to land. To whom the angel said, Open the fish, and take the heart and the liver and the gall, and put them up safely * * * if a devil or an evil spirit trouble any, we must make a smoke thereof before the man or the woman, and the party shall be no more vexed. As for the gall, it is good to anoint a man that hath whiteness in his eyes, and he shall be healed."

When the two had reached Raguel, then Raphael (or Azarias) spoke to Raguel for Sara, and she was given to Tobias for his wife. And, on their wedding night, Tobias, acting according to the instructions of the angel, took "the ashes of the perfumes, and put the heart and the liver of the fish thereupon, and made a smoke therewith. The which smell when the evil spirit had smelled, he fled into the utmost parts of Egypt, and the angel bound him."

Raphael having gone to Media and collected for Tobias the ten talents of silver which were due from Gabael of Rages to Tobias's father, and having then returned to Tobias, he and Tobias set out for Nineveh, the home of Tobit. They took with them Sara, Tobias's wife, and her portion, which was half the goods, servants, cattle, and money of Raguel.

The arrival of Tobias and the angel, as well as the manner whereby Tobit's eyes were cured, is then related by the sacred author as follows: "Then Raphael said to Tobias, thou knowest, brother, how thou didst leave thy father:

"Let us haste before thy wife, and prepare the house.

"And take in thy hand the gall of the fish. So they went their way, and the dog went after them.

"Now Anna sat looking about toward the way for her son.

"And when she espied him coming, she said to his father, Behold, thy son cometh, and the man that went with him.

"Then said Raphael, I know, Tobias, that thy father will open his eyes.

"Therefore anoint thou his eyes with the gall, and being pricked therewith, he shall rub, and the whiteness shall fall away, and he shall see thee.

"Then Anna ran forth, and fell upon the neck of her son, and said unto him, Seeing I have seen thee, my son, from henceforth I am content to die. And they wept both.

"Tobit also went forth toward the door, and stumbled; but his son ran unto him,

"And took hold of his father; and he strake of the gall on his father's eyes, saying, Be of good hope, my father.

"And when his eyes began to smart, he rubbed them;

"And the whiteness pilled away from the corners of his eyes: and when he saw his son, he fell upon his neck.

"And he wept, and said, Blessed art thou, O God, and blessed is thy name for ever; and blessed are all thy holy angels:

"For thou hast scourged, and hast taken pity on us: for behold, I see my son Tobias. And his son went in rejoicing, and told his father the great things that had happened to him in Media.

"Then Tobit went out to meet his daughter-in-law at the gate of Nineveh, rejoicing, and praising God: and they which saw him go marveled because he had received his sight."—(T. H. S.)

Todd, Frank Chisholm. An American ophthalmologist of international reputation. He was born at Minneapolis, Oct. 15, 1869, son of Shubal D. and Lidana Ann Whicher Todd. He attended for a time the academic college of the University of Minnesota, but did not complete the course. He received, however, at the same university the degree in dentistry in 1891 and the Doctor of Medicine in 1892. Having studied ophthalmology and oto-laryngology at New York, London, Paris, Berlin and Vienna, he returned to Minneapolis, and, in 1899, was made professor of the eye, ear, nose and throat at his alma mater. In 1902 he was made chief of the department, a position which he held until his death.

Dr. Todd was surgeon to the University of Minnesota, the Hill Crest Surgical, St. Barnabas, City, Northwestern, and Asbury Hospitals, and to the Chicago, Milwaukee and St. Paul Ry. He was a Fellow of the American Academy of Ophthalmology and Oto-Laryngology, of the American College of Surgeons, a Member of the Association of Military Surgeons, and, in 1914, was President of the Minnesota Academy of Medicine. He was the secretary and one of the organizers of The American Board for Ophthalmic Examinations.

Shortly after the United States entered the war. Dr. Todd enlisted in the Medical Reserve Corps as Major. Later he was advanced to a Lieutenant Coloneley. He was first assigned to the base hospital at Camp Dodge, of which he was shortly made commanding officer.

Lieut.-Col. Todd was a man of medium height, spare of build, with a small mustache, blue eyes and sandy hair. He was slow, methodical, deliberate, thorough. He was very fond of history, a Republican in politics, a member of no church, yet not a disbeliever. He married, Oct. 15, 1894, Mary Mabel Odell. Of the union were born four children, Margaret, John, Ann, Mary Mela. The Doctor died

Frank Chisholm Todd.

from lobar pneumonia at the Presbyterian Hospital, Chicago, July 4, 1918. His body, returned to Minneapolis, was given a funeral with military honors. His place in ophthalmology and in the hearts of all who knew him, cannot soon be filled.—(T. H. S.)

Tolamine. A combined chlorine agent used mainly as a mild disinfectant in wounds. It is less irritating but more powerful than the hypochlorites. See **Military surgery of the eye.**

Tolles's vertical illuminator. A vertical illuminator for the microscope. It consists of a small rectangular prism placed above the front combination of the objective and totally reflecting the light entering the end of the prism which projects laterally through the objective. This form has been found especially excellent for investigating fine rulings on metal surfaces.

Tollkirsche. (G.) Belladonna.

Tollkraut. (G.) Belladonna; also applied to datura stramonium.

Toluidine blue. Zinc-chloride double salt of dimethyl-toluthionine. This agent is a dark-green powder soluble in alcohol; less soluble in water. An aniline dye-stuff occasionally used, like methylene blue (q. v.), in ocular therapeutics, generally in 1:1000 solutions which are of a deep-blue color.

Clarence P. Franklin (Wood's *System of Oph. Therapeutics*, p. 572) regards it as a most efficient remedy in muco-purulent conjunctivitis and as practically a specific for the Koch-Weeks and Neisser forms of the disease. The usual ten days to two weeks' discharge of "pink eye" is reduced to four to six days, and with this treatment there seems to be less chance of a fresh infection; at least the writer has never seen a return in any instance among many cases.

In ophthalmia neonatorum and gonorrheal ophthalmia of the adult the purulent process is markedly and rapidly lessened.

It is to be used three times a day (in 1:1000 solution, dropped into the conjunctival sac) and alternated with solutions of adrenalin and boric acid. This treatment has given uniform results with no untoward symptom except that, rarely, a patient of pronounced susceptibility complains of slight stinging on its first instillation.

Abrasions of the cornea stain with toluidin blue rapidly but less vividly than with fluorescein, thus failing to adequately take the place of the later chemical, except in that it may be more bactericidal and, therefore, more useful in protecting an open surface on the cornea.

Although toluidin blue stains the skin readily, it is easily removed by water, so that there need be no hesitation in its use.

Tomomania. Undue eagerness to perform surgical operations. 2. A hysteric desire to be operated upon surgically.

Tone. The harmonious relation of the colors of a picture.

Tonguing the eye. This vulgar method of removing foreign bodies is not uncommon. H. V. Würdemann (*Ophthalmic Record,* March, 1915) has reported a case of a man who presented a superficial ulcerative keratitis. His wife had removed a foreign body from his eye with her tongue. The pneumococcus and the diplobacillus of Morax-Axenfeld were found in smears. Healing was slow. The wife came under treatment later, and it was possible to cultivate the pneumococcus from her tongue.

Tonogen. This is one of the numerous European succedanea of our adrenaline. It is commonly used in Hungary and is sold in the usual 1:1000 solution.

Tonograph. A recording tonometer (q. v.).

Tonometer. Ophthalmomanometer. (Incorrectly) Tenometer. Ocular manometer. See **Tonometry.**

Tonometry. Ophthalmotonometry. Ophthalmomanometry. Ocular instrumental tonometry is the measurement of the tension of (pressure within) the eyeball by means of instruments of varied construction, the most practical of which is called the *tonometer.*

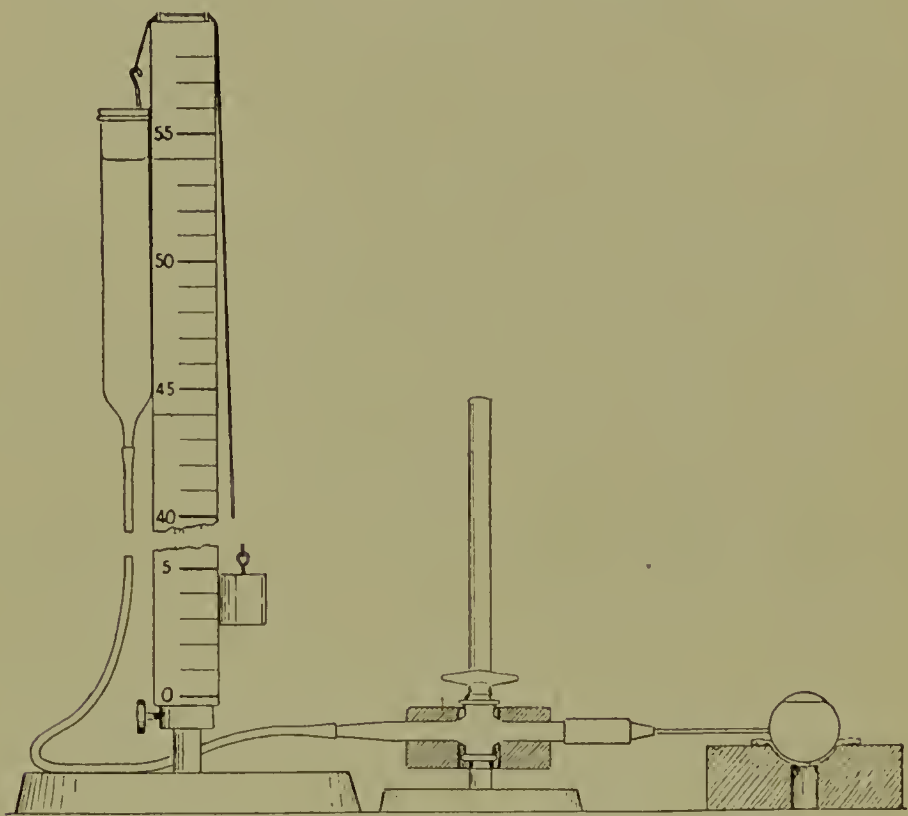
The theory and practice of this method and the devices employed in carrying it out have already been discussed and illustrated to some extent under several captions in this *Encyclopedia.* See, in particular under **Ophthalmomanometer,** p. 8295, Vol. XII; **Circulation of the intraocular fluids,** p. 2256, Vol. III; **Examination of the eye,** p. 4632, Vol. VI; as well as under **Blood pressure,** p. 1227, Vol. II; on p. 10366, Vol. XIII; and under **Glaucoma.**

Strictly speaking, in *ophthalmomanometry* the intraocular pressure is measured directly by connecting the interior of the eye with a manometer (q. v.). A number of devices for this purpose are described by Parsons (*Pathology of the Eye,* p. 1049), and one of them, used by Priestley Smith in his experiments, is pictured in this text.

Bearing upon the value of tonometry in the *differential diagnosis of eye diseases,* Marbaix (*Annales d'Oculist.,* p. 27, Vol. 155, 1918) calls attention to various cases in which the use of the tonometer cleared up the diagnosis. In a girl of 17 it showed a rise of tension to 35 mm. that called attention to a mild cyclitis previously undetected. In a case of parenchymatous keratitis a reading of 70 mm. Hg. led to substitution of pilocarpin for the mydriatic, reducing the tension to normal. Peripheral choroiditis was also revealed by the rise of intraocular pressure. In high myopia the unsuspected glaucomatous complication 50 to 70 mm. was thus discovered. In diabetes

with impaired vision high tension was found which was reduced by pilocarpin until the patient was brought into better condition for operation.

Priestley Smith (*Br. Journ. of Ophthalm.*, p. 293, July, 1919) has published an essay on *tonometric values,* which forms a supplement to his earlier paper on the limitations of the tonometer (*vide supra*). He reviews and agrees with the contention of W. McClean (*Archives of Ophthalm.*, p. 23, 1919) that the latter's experiments throw much doubt on the indications of the Schiötz tonometer.



An Ophthalmomanometer. (Priestley Smith.)

Priestley Smith reiterates his belief that the Schiötz tonometer measures the impressibility of the eye and can indicate changes of intra-ocular pressure in a given eye with a great certainty. For example, it has proved (by McClean's experiments) that in animals and in man, and that in glaucomatous as well as in healthy eyes, the intra-ocular pressure falls considerably during the introduction of ether anesthesia.

The tonometer cannot measure the intra-ocular pressure with precision because the relation of the impressibility of the eye to the intra-ocular pressure is different in different eyes. In other words, exact mercury equivalents for the degrees indicated by the pointer cannot be given.

Approximate mercury equivalents are found by testing a number of human eyes with the tonometer and a manometer almost simultaneously. It is not possible, however, to carry out the test under conditions quite like those under which the tonometer is ordinarily used. Equivalents found by experimenting on animal eyes are likely to be incorrect for human eyes.

The value of any new tonometer will depend not merely on the excellence of its mechanism, but also, and essentially, on the tests by which it was regulated. Full details of the method and of the results should be given.

The Schiötz curves are not likely to be precisely correct, even for the average living eye, for the reasons just given. They are necessarily sometimes at fault for the individual eye. On the other hand, it is not proved, and it is not likely, that the instrument errs to the extent that McClean's experiments suggest.

TONOMETERS.

As Parsons (*Pathology of the Eye*, p. 1044) points out, the devices used in *instrumental tonometry* are of two kinds—the impression tonometer and the applanation tonometer.

Impression tonometers are intended to measure the depth of the impression made by part of the instrument or to register the dimpling of the globe produced by a given force. They are very numerous, various models having been described by von Graefe, Lecoultre, Donders, Lazerat, Priestley Smith, Helmbold, Snellen and a number of others. The most important of them will be depicted or described in this section.

Applanation tonometers are said by Parsons to be more accurate than the impression instruments, their principle depending upon the fact that

$$p = J + N,$$

p being the amount of pressure applied to the exterior of the eyeball, J the component of the intraocular pressure acting on a given area and N the vertical component of the tension of the walls acting upon the same area. N varies and cannot be accurately measured, but in the instruments of Fick (1888), Imbert (1885) and Weber (1868) it was found possible to eliminate this factor.

That accurate results may be obtained the *area* must be exactly flattened, because if it is depressed the surrounding wall will rise sharply around the circumference and the reading will be too low.

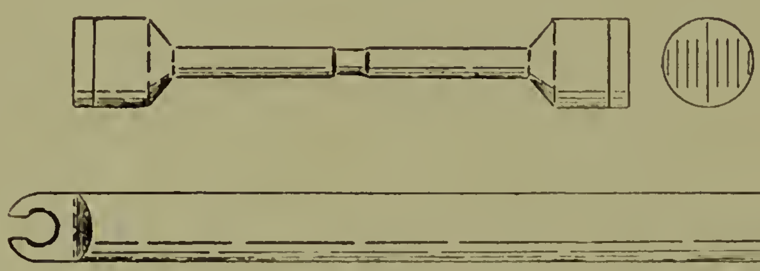
As Parsons says, instruments of two kinds may be constructed on this principle, (1) those in which the external pressure is constant

and the depressed area is measured, and (2) those in which the depressed area is constant and the external pressure is measured. Maklakow's tonometer (1885) is of the first type, that of Fick (1888) modified by Koster and Ostwalt (1895) belong to the second class.

Coburn's ophthalmomanometer. This tonometer is described and pictured on p. 8295, Vol. XII and p. 4635, Vol. VI of this *Encyclopedia.*

Dor's and Lecoultre's tonometer. A tonometer constructed on the same principle as Hamer's tonometer, but having the position of the peg regulated by a screw. The spiral spring is replaced by a straight steel spring, which is not very long, so that the tension rapidly increases with the deep pushing of the peg.

Graefe's tonometer. A tonometer consisting of a small rod which is pressed against the eye by means of a loaded lever. A scale shows the degree to which the peg or style can overcome the tension of the eye with various degrees of loading.



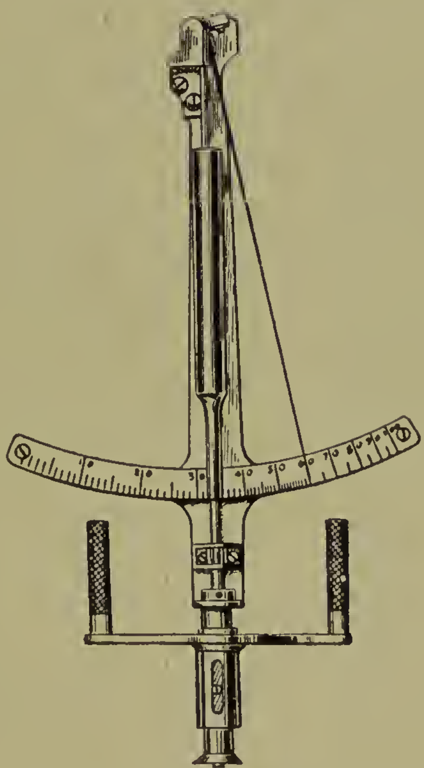
Modified Maklakow Tonometer. (Priestley Smith.)

Hamer's tonometer. A tonometer consisting of a metallic tube out of which a peg or style projects. The latter is connected with a wound-up watch-spring, so that by pressing upon the eye it has to overcome the constantly increasing tension.

Maklakow tonometer. Priestley Smith (*Ophthalm. Review,* p. 85, March, 1915) has set forth the merits of a modified Maklakow tonometer (adapted for measuring the intraocular pressure). See the accompanying figure. He says of it that like the original instrument it weighs 10 grm., but the end-surfaces have a diameter of 9 instead of 10 mm., and on each of them is engraved a millimetre scale. Before applying the instrument the cornea is oiled as thinly as possible with a camel-hair brush. By means of the holder the instrument is gently lowered on to the cornea so that it stands on it vertically and presses on it only by its own weight. The polished surface of the glass takes a well-defined circular print of the flattened area of the cornea. The diameter of the print is read on the scale—with a lens if necessary. Priestley Smith thinks that this tonometer has many

merits. It is easily tested, for if the scale be true and the weight be 10 grms. all requirements are fulfilled. It is easily and quickly applied, faults of position being avoided without much difficulty. It cannot cause abrasion of the cornea. Its indications are read deliberately when the instrument has left the eye. These points are in its favor. But as an index to the impressibility of the eye the Maklakow is decidedly less sensitive than the Schiötz.

The *McLean tonometer*. The advantages of this instrument (*Am. Journ. of Ophthalm.*, p. 417, June, 1919) are: The calibrations on the scale are in millimeters of Hg., as determined by actual manom-



O. H. McLean Tonometer.

eter readings. The scale is placed just above the finger piece and as close to the eye as possible so it can be more easily observed by the operator. To prevent capillary attraction of any fluid that might remain on the cornea and reduce friction to a minimum, the plunger has a space of 1 mm. between it and the base, and is held in position by the rounded ends of three hardened steel bearings placed at 120° from each other. The limits of normal tension by the McLean instrument, 22 mm. Hg., the minimum; and 40 mm. Hg., the maximum, although the author states that he has seen a few eyes with a tension of 36 mm. Hg., which had symptoms of glaucoma. In a case of ab-

solute glaucoma, before enucleation for pain, the tension was Schiötz 40, McLean 58.

Monnik's tonometer. A modification of Hamer's tonometer in which the immovable tube is replaced by two pegs, which can be pushed in with the slightest possible friction. The two pegs act together upon an index which shows on a dial-plate the change in position of the two pegs. A second index moves with the middle peg, which is under the increasing pressure of a short spring.

Schiötz tonometer is the best known of these devices. It is pictured and described (together with the *Gradle modification*) on p. 4630, Vol. VI of this *Encyclopedia*.

The *Priestley Smith tonometer,* of complicated mechanism, is pictured in Parsons' *Pathology of the Eye,* p. 1049.

Souter's tonometer. This instrument (*Interstate Med. Jour.,* October, 1916) is extremely simple in construction and method of application, giving direct readings, which are taken with the patient in upright position and thus a diagnosis can be rapidly made. It contains fewer parts, is smaller and more portable, as well as less expensive, than other tonometers which are now in use, and it is therefore claimed by the inventor that on account of these facts this tonometer is especially well adapted for clinical and hospital use. The instrument is about the size and weight of a fountain pen, and may be carried in the vest pocket. It is constructed entirely of metal, and consists of a light tubular body, with side finger grips and open scale, and has also internal end caps, which support a resiliently balanced sound with piston index.

A stop or break is provided near the forward end of the casing on either side for temporarily retaining the sound in diagnostic position for reading. The counter-poise construction is exact, and includes anti-friction bearings for the sound and a compensating precision spring, which is made of uniformly drawn phosphor-bronze wire. As the elastic limit of the spring greatly exceeds the requirements, the reliability of the instrument should remain unimpaired irrespective of time or use. The scale calibrations are accurately cut into the metal, and represent pressure in millimeters of mercury. The instrument is well finished in black nickel, the scale contrasting clearly in white. The contact portion of the sound may be sterilized in the usual manner without injury. Complete directions of technique are furnished with the instruments by the manufacturers.

Stephenson-Wolinski tonometer. See p. 4632, Vol. VI of this *Encyclopedia.*

Verlaan's tonometer. This instrument consists of a tube in which

three isolated pegs can be pushed in or out. The middle peg is connected with a spiral spring the tension-power of which increases with the pressure. The two outer pegs may be moved with the slightest possible friction, and carry scales which run on a vernier connected with the middle peg.

Weber's tonometer. A tonometer consisting of a peg which acts with increasing spring power on the sclerotic until its curvature to a certain extent is flattened to a plane.

VALUE OF TONOMETRY.

W. Stock (*Klin. Monatsbl. f. Augenheilk.*, 48, 1910) was among the first to report his investigations with Schiötz's tonometer on 100 normal eyes and on glaucomatous eyes, before and after operation. His conclusions are: 1. The instrument gives, after short practice with it, reliable clinical figures. If in a publication the tension of an eye is to be mentioned, it must be measured accurately. Statements like T + 1, etc., must be discarded. 2. The tension of the normal eye fluctuates between 12 and 26 mm. Hg. 3. As operations are most effectual in recent cases, tonometry is a good means for an early diagnosis and indication for operation. In glaucoma simplex we need not wait for the appearance of excavation with atrophy or contraction of the field of vision, but should operate if the tension is increased and cannot be decreased by eserin or pilocarpin. 4. The tonometer is of value to determine whether we should keep a patient under medicamentous treatment. If we can objectively prove increased tension we can much more urgently recommend an operation to the patient, even with normal vision and visual field. Only in rare cases of glaucoma simplex does the tension, measured with the tonometer, lie within normal borders. In such cases the tension has been lower before and this relative increase of tension suffices to produce the glaucomatous complex of symptoms.

Hans Oeding (*Inaugural Dissertation,* Rostock, 1911) agrees as to the usefulness of the Schiötz instrument. Small differences in the tension are recorded by the instrument that would possibly pass unnoticed in palpation.

Langenhan experimented with eyes under normal conditions, and with those affected by disease and medication. He found that in normal eyes the instillation of holocain, 2 per cent., and atropin, 1 per cent., did not affect the tension, but that cocain, 10 per cent., reduced the tension in many instances through the constriction of the vessels; that pilocarpin, 2 per cent., and eserin, 1 per cent., reduced the tension some 1-5 mm. of mercury. He also reported that tension was

reduced on tenotomy; as also in advancement of the straight ocular muscles.

High grade myopia is not accompanied usually by decrease in tension. Eyes in Basedow's disease, also with beginning intra-ocular tumor, often show decrease in tension. The effect of eserin and pilocarpin upon glaucomatous eyes Oeding found to vary. Commonly the pilocarpin was weaker in its action than eserin. The greatest decrease in tension was found to be three-quarters to one hour after instillation. The combination of cocain with eserin or pilocarpin is not recommended because of the mydriatic property of cocain.

These two observers' results are thus summarized: The Schiötz tonometer is a practical instrument for the measuring of intra-ocular tension and a help in the diagnosis and therapy of glaucoma. As a local anesthetic they found 2 per cent. alypin to be preferable to holocain, which has been much used. In 122 normal eyes the instrument showed a measurement from 13.5 to 27.00 mm. of mercury. The commonest pressure in adults was 21 mm., and in children 18 mm. of mercury. The measurement of the tension and the testing of the vision of 39 patients who had been operated upon for glaucoma showed that iridectomy neither prevented further loss of vision nor the reappearance of increased tension.

Heilbrun (Graefe's *Archiv für Augenheilk.*, 79, 2, 1911) makes out a strong case in favor of every ophthalmic surgeon using the tonometer as a routine matter, not only for diagnosis, but also to be able to judge of the results of treatment, whether of an operative, or of a therapeutic nature, and as a guide to further operative procedure in an eye which has been already operated upon.

Wessely (*Oph. Year-Book*, p. 197, 1912) declares that *too much reliance must not be placed* on the absolute values obtained with the Schiötz tonometer, however useful the instrument may be for comparative purposes.

A series of *tonometric measurements of normal and glaucomatous eyes* was made by Bietti. He saw three cases of simple chronic glaucoma whose tension lay within normal limits. Using pilocarpin, he several times found the least diminution of tension to occur during the maximum of miosis; and in one normal patient, with either pilocarpin or eserin the tension was raised during the whole period of observation, in spite of the existence of miosis. The reduction of tension commonly obtained after using eserin was more intense and of much longer duration than that caused by pilocarpin. The eye easily habituates itself to the action of eserin, in the sense that the hypotonicising effect becomes less marked. In glaucomatous eyes, de-

cidedly lower tension followed paracentesis with eserin than when either was used alone.

P. Van Gelder (*Klin. Monatsbl. f. Augenheilk.*, Nov., 1911), after numerous experiments with the tonometer of Schiötz, concludes that in a quiet patient there is no difference in the ocular pressure, no matter which speculum is used to hold the eye open during the operation for cataract or glaucoma. Similarly the intraocular pressure is enormously increased if the patient pinches his eyes, irrespective of the kind of speculum used. Therefore, the speculum having a weak spring, which gives least discomfort to the patient, is to be chosen. Section of the external canthus allows the operator more room, but the patient can raise the tension very high by straining. The writer has found that introduction of a suture through the upper and lower lid muscles, held by an assistant, has a marked effect on tension. The tonometer registers a normal pressure of 25 mm. mercury in an eye when the patient is quiet. The pressure will raise by strain to 35 or 40 mm. when the thread through the upper lid is tightly held. When the lower thread is held, the patient cannot with his utmost efforts raise the pressure above 27.5 mm. The thread must be introduced through the muscles of the lid at their attachment to the malar bone and held firmly by an assistant.

As a study in tonometry, J. Wegner (*Archiv. f. Augenh.*, lxviii, p. 290, 1912) tested 100 normal eyes with especial regard to the relation of the *intraocular pressure to age*. He divided his subjects into three groups, the first to 25 years, second 25 to 50 years. third 50 to 75 years. The first group, 17 patients and 34 eyes, showed a lowest tension of 18, highest of 30, and average of 24 mm. The second group, 19 cases and 32 eyes, showed lowest 15, highest 25, average 21. The third group, 18 cases and 34 eyes, showed lowest 13, highest 22, average 18. A general table gives 4 eyes as showing 13 mm., 9 as 15, 22 as 18, 6 as 19, 1 as 21, 35 as 22, 15 as 25, 1 as 27, and 7 as 30 mm. The average for the 100 was 21. Wegner concludes that normal pressure lies between 13 and 30, that with increasing age normal pressure becomes less, and hence one must differentiate according to age. A further table, of experiments with eserin, shows greatest reduction of tension by the drug in 12 eyes of 6 patients to range between 4 and 10 mm.

Orr (*Oph. Year-Book*, p. 164, 1913) has studied the Schiötz tonometer from the physical standpoint; he holds that there is a physiological inexactitude in its readings, to the extent of the weight of the instrument applied to the eye; also the zero reading varies with the curvature of the surface to which the foot-plate is applied. The

latter point was studied by experiments on steel balls, on artificial eyes, and on living human eyes; in the last case the steel piston rod was replaced by a light vulcanite rod. As the radius of curvature of the cornea rarely varies beyond the range of from 7 mm. to 8.2 mm., the probable variations in the readings in healthy corneas do not pass beyond 1 or 1.5 markings of the scale. Again the readings vary with the resiliency of the cornea. Consequently those taken on a conical cornea are far too low. For practical purposes we can disregard the error due to the weight placed on the eye (so long as the reading is kept to the first five divisions of the scale, as Schiötz recommends should be done); and probably we can assume that the resiliency of ordinary corneas is approximately the same. The mean of three readings should be taken and even then an error of 1 to 1.5 divisions on the scale is probable; this implies an error varying from 3 mm. Hg. with the lower tensions, to one of 10 mm. with the higher. The results of a large number of investigations on animal and human eyes have shown that the Schiötz tonometer is of practical value for clinical purposes, though the absolute value stated in millimeters of mercury may possibly not be reliable within fairly wide limits. Water manometer readings of an eye are complicated by alterations in curvature when the needle is introduced into the anterior chamber, whilst when the vitreous is penetrated, the needle tends to become blocked.

The wider use of the tonometer shows changes of intraocular tension attending many of the alterations of ocular nutrition. Some of these have been illustrated by cases reported by Luedde. In myopia accompanied by ocular pain, the tension of the eyeball was found slightly increased; and its reduction by miotics gave relief. After needling of soft cataract increased tension was noted. In secondary glaucoma of certain forms, atropin and cocain produced no rise of tension or even caused a decrease. Intraocular tumor showed increased tension before any glaucomatous outbreak. The tension in retinal detachment, iritis, choroiditis, keratitis and optic atrophy showed notable variations from the normal.

The tonometer is, perhaps, more necessary in the study of diminished tension than in glaucoma. An increase of tension 20 to 100 mm. from the normal will be noted in cases of glaucoma. But the whole range of hypo-tension is included within 15 mm. below the normal limit. Both increased and diminished ocular tension are observed in uveal inflammations, and may come to have important practical significance in the differentiation of cases.

Priestley Smith (*Ophthal. Rev.*, March, 1915) on the *limitations*

of the Schiötz tonometer notes that there are other factors besides intra-ocular pressure which influence the impressibility of the eyeball and hence the accuracy of the readings with the tonometer; these factors are the size and structure of the eyeball. Eyes with the same pressure will sometimes give different readings and eyes with different pressures will at times give the identical readings.

He puts and answers the questions: (1) With what degree of accuracy can we measure the impressibility of the eye? (2) With what degree of accuracy does the impressibility indicate the intra-ocular pressure? He conducted a series of experiments chiefly on human eyes post-mortem, but also on excised eyes of sheep and bullocks. He demonstrates that the reliability of the readings taken with the tonometer of Schiötz depend greatly on the position of the instrument—whether this was exactly on the summit of the cornea and perfectly vertical; he gives diagrams showing the correct position and also several possible faulty positions of the eye and instrument and illustrates how each of these vitiates the results of the readings.

He contends that in recording the tonometric observation, the reading and not the supposed equivalent should be given; the former is fact but the latter is an inference, and this inference may be more or less correct. He criticizes the statement that the pressure in healthy eyes varies from 13 to 27 mm. of mercury as being most unlikely since it implies that the pressure of the intra-ocular fluid and that of the blood in the retinal and uveal veins is twice as great in some eyes as in others within normal limits. Since we find that the pressure in different normal eyes seems to differ by 8 or more mm. of mercury as measured by the tonometer and yet know that in reality there is no difference in pressure whatever, we are certainly justified in doubting the inference above alluded to.

In his own words: "We are told that when the tonometer indicates an intra-ocular pressure of more than 27 mm. Hg., the presence of glaucoma should be suspected. Also that glaucoma may co-exist with a pressure of 21 or 22 mm. Hg. These are inferences. If we want the facts we must re-translate the figures. Then the statements are that a reading smaller than 2.5 should be regarded as a danger signal, and that glaucoma may be present even with a reading of 4. These data, if confirmed, are very valuable; the original statements are dubious pathology. No doubt some eyes are damaged by degrees of pressure that others can tolerate with impunity, but the tonometer can not tell us what these risky pressures are."

He is careful to indicate that he does not regard the tonometer as a useful instrument; though the Schiötz tonometer can not measure

absolute pressure, it can indicate change of pressure with great precision. Applied to the same eye at different times, e. g., before and after an operation, before and after the use of a certain drug, at different hours of day or night, and so forth, it can give invaluable aid in determining the occurrence of pressure changes when these are doubtful. Again, as between the two eyes of the same person, when these are presumably alike in structure, it may be relied on to detect with certainty a difference of pressure much smaller than is discoverable by the finger.

The smallest difference which the tonometer can be relied upon to detect depends on the skill of the operator and the amenability of the patient. However, even with the limitations necessary on account of the influence of structural differences in eyes, the tonometer is far more trustworthy than the finger as an index to the intra-ocular pressure, for its limitations apply also to the finger test, and it has no prejudices. To emphasize the importance of recording readings and not supposed equivalents, he points out that Schiötz himself has set the example of so doing. The chart is valuble as showing approximately the average value of any given reading, but not as a guide to the actual value in an individual case. This article is not an attack on the Schiötz tonometer, but rather a defence of an admirable instrument against demands with which no instrument can possibly comply.

Edward Jackson (*Ophthalmology*, p. 437, Apr., 1917) has found the tonometer of Schiötz, or the convenient modification of it by Gradle, an instrument of great practical and scientific value. A single test with it cannot be relied on as indicating with any certainty the intraocular pressure. A comparative test with the two eyes, when one shows nearly the average reading for a normal eye, and the other a marked departure from it, raises a strong presumption of departure from the normal intraocular tension in the latter eye. Repeated tests of the same eye giving differences in the tonometric reading indicate with certainty pathologic change, generally a change in the intraocular tension, so that the instrument gives very accurate indications of the course of the case.

So far from diminishing the usefulness of the tonometer the readings obtained in uveitis indicate a larger field for its application in which it will be of very valuable assistance. It seems certain that diminished intraocular tension is not a constant or pathognomonic symptom for all forms and stages of uveitis.

Tonophant. An instrument for rendering acoustic vibrations visible.

Tonoscope. An apparatus for rendering sound visible by registering the vibrations on a screen.

Tonsillitis. Indirectly this infective disease has been responsible, it is claimed by Jacobson, for *paralysis of the ocular muscles* apart from diphtheria. Ziem (*Allgem. Med. Centralzeit,* 1886) reports a case of *conjunctivitis;* Menacho (*Internat. Oph. Congress,* 1894) *optic neuritis;* and Mitvalsky *orbital cellulitis.*

Probably as the center of *focal* infections the tonsils bring about other and less evident ocular changes, such as are seen in uveal tract diseases.

Wescott (*Oph. Year-Book,* p. 136, 1916) has seen a number of cases of iritis due to tonsillar infections, which had existed for many years. What precipitates the inflammation in the eye when the systemic infection has been present so long, and innocuous, so far as the eye is concerned, is difficult in most cases to say. But that it may be due to slight trauma, as in tuberculous joints, seems evident from the following case: An engineer sustained an injury to one eye from a blast of dust. Six days later the eye was very red, and sensitive to light and the cornea hazy. There was no foreign body in the cornea, and the pupil reacted perfectly. The iris was normal in color but slightly swollen from hyperemia. Four days later there was well marked iritis with adhesions. The tonsils were not acutely inflamed but pus could be expressed from one of them.

Seggel (*Klin. Monatsbl. f. Augenheilk.*, Aug., 1907) has reported a case of *blindness* (optic atrophy) due to cerebral thrombosis following phlegmonous tonsillitis. This writer claims that, having excluded thrombosis of the central retinal vein (Mitvalsky), rise of intra-orbital pressure of the right side, right-sided exophthalmos due to obstruction from swelling and infiltration of the orbital tissue (Knapp), and direct involvement of the optic nerve by swelling of the orbital tissue (Schmidt-Rimpler), we must look for an intracranial cause. This cause he locates in the thrombosed cavernous sinus, which may injure the chiasma or the intracranial part of the optic nerve, either by compression of nerve fibres, by setting up neuritis, or by interruption of the blood supply to these parts. The quick onset of complete blindness, and the termination in pure optic atrophy suggest that the last of these is the cause of the blindness. The chiasma gets its blood supply from several sources, while the intra-cranial segment of the optic nerve is supplied only from two. Further, according to Henschen's scheme, the uncrossed fibres which correspond to the portion of the field of vision preserved in Seggel's case, form a compact bundle in the lower aspect of the intra-cranial

optic nerve, while in the chiasma these uncrossed fibres are mixed with crossed fibres. Hence a vascular lesion in the former situation would be more apt to leave this particular group of uncrossed fibres intact than a similar lesion in the latter situation.

Thus the writer concludes that the blindness resulted from obstruction to the blood supply to the intra-cranial portion of the optic nerve.

Tonsure of the cornea. See **Peritomy,** p. 9613, Vol. XII of this *Encyclopedia.*

Tophus (pl. *tophi*). Chalazion.

Tore. A surface or solid generated by the revolution of a conic about an axis in its plane.

Toric. Pertaining to a tore; used in optics with reference to a lens whose surface is a portion of that of a tore.

Toric lens. A lens, one of whose surfaces, in lieu of being spheric, has two different arcs of curvature intersecting each other at right angles and said to constitute the principal refracting meridians of the surface, or lens. Beauvois claims the introduction of toric lenses into ophthalmology for Pouillain. See **Lenses and prisms, Ophthalmic,** p. 7333, Vol. X of this *Encyclopedia.*—(C. F. P.)

Torresini, Giuseppe. An Italian surgeon, who flourished about the middle of the 19th century, and who seems to have paid considerable attention to diseases of the eye. He wrote neither book nor article on any ophthalmic subject, but some of his methods of treatment appear in the book of his son, Michelangelo Torresini, "*Trattato di Oculistica.*"—(T. H. S.)

Torresini, Michelangelo. An Italian ophthalmologist, who flourished about the middle of the 19th century. He wrote "*Trattato di Oculistica del Dottore Michelangelo Torresini di Padova,*" etc. (Parte Prima, Padova, 1856, 53 pp.); "*Anatomy and Physiology of the Eye.*" Parte Seconda, Padova, 1857. 212 pp.; "*Ocular Pathology and Treatment.*")—(T. H. S.)

Torsiometer, Brewer's. See p. 1290, Vol. II of this *Encyclopedia.*

Torsion, Oculomuscular. The rotation of the globe by the action of certain of the extrinsic muscles. See **Cyclophoria**; as well as **Muscles, Ocular.**

Torticollis, Ocular. A term applied by Quignet to torticollis developed from inequality in the sight [or oculomuscular balance] of the two eyes.

Sydney Stephenson (*Proc. Roy. Soc. Med.,* June, 1913) has reported a case of ocular torticollis in a girl aged 9½ years. "Habitually the head is inclined toward the right shoulder 30 degrees from the

vertical, but it can be straightened at will. There is no tension on the sternomastoid muscle, no twisting of the head, little asymmetry of the face, no deformity of the skull. The spine is slightly inclined to the left in the cervical region, to the right in the dorsal region, to the left in the lumbar region. There are the usual accompaniments of a right dorsal curve. With the head in the abnormal position, the right eye is usually free from squint, but at other times it is inclined downward from eight to ten degrees (strabismus deorsumvergens). With the head straight, the right eye squints downward or the left deviates upward (strabismus sursumvergens). When the head is tilted there is usually no diplopia; when it is straight double images are seen. The eyes are healthy apart from the squint. Hyperopia 0.25 D. Vision is normal. Visual fields for white are full in both eyes."

Bankhart and Downey (*Oph. Year-Book,* p. 100, 1913) report a case of torticollis of ocular origin; Isakowitz describes one due to congenital paresis of the trochlearis muscle.

Tortoise, The. In ancient Greco-Roman times, the blood of a tortoise was used as a sharpener of the sight. The gall, mixed with honey, was now and then employed for glaucoma. (See **Glaucoma,** *History of the term.*)—(T. H. S.)

Total ophthalmoplegia. Complete ophthalmoplegia. These terms are applied to a paresis or paralysis of all the muscles, external or internal, that supply the ocular apparatus. It rarely happens, however, that no muscle escapes, and still rarer is it that the muscles of both eyes are affected in their entirety. External ophthalmoplegia is almost invariably a nuclear palsy and is the result of a lesion affecting the nuclei of the ocular muscles in the floor of the fourth ventricle and in the aqueduct of Sylvius. See also, **Ophthalmoplegia** and **Muscles, Ocular.**

Total reflection. The complete reflection of an incident beam of light which takes place at the bounding surface of transparent media when the angle of incidence is greater than the critical angle.

Toti's operation. See **Dacryocystorhinostomy.**

Toughened glass. Glass hardened by treatment analogous to that used in the hardening of steel.

Tourmalin. A doubly-refracting mineral crystal, crystallizing in the rhombohedral system, often in the form of a three-, six-, or nine-sided prism terminated by three faces of an obtuse rhombohedran. It often exhibits hemimorphism, the opposite extremities of a prismatic crystal showing an unlike development of planes. Its fracture is uneven or conchoidal; its hardness is a little greater

than that of quartz. In composition tourmalin consists principally of a boro-silicate of aluminum and magnesium, but contains frequently iron, lithium, and other elements. Some varieties are transparent, some translucent, some opaque. Some are colorless, and others green, brown, red, blue, and black, the last being the most common. Frequently the color varies in different parts of the crystal: thus, there may be a green exterior part about a red nucleus, or a crystal may be red at one end and green at the other, etc. Achroite is a colorless variety from Elba; rubellite is a pink or red variety containing lithium; indicollite is a blue or bluish-black variety; aphrizite is a black variety from Norway. Common black tourmalin is often called *schorl*. The transparent red, green, blue, and yellow varieties are used in jewelry: here belong the Brazilian sapphire, the Brazilian emerald, etc. Tourmalin occurs most commonly in granite, gneiss, and mica-schist. It is found in England, Scotland, Sweden, America, Spain, Siberia and elsewhere. Sections cut from prisms of tourmalin are much used in polarizing apparatus. It exhibits marked pyro-electric phenomena which are connected with its hemimorphic crystalline structure. Only a single polarized ray is transmitted through a thick crystal of tourmalin: but if the crystal is thin, two rays of unequal intensities are transmitted, and these rays are found to be polarized in perpendicular planes. The directions of the rays are found to follow Huyghen's construction, so that we reach the conclusion that tourmalin is a doubly-refracting crystal, in which the ordinary ray is absorbed if the crystal is thicker than one or two millimeters, while the extraordinary ray is transmitted without much loss of intensity. Calcite acts like tourmalin with respect to very long waves. The transmissive power of calcite, for infra-red rays of wave-lengths between 1 and 5.5 microns, has been studied by Merritt; he finds that beyond 3.2 microns, the ordinary ray is entirely absorbed, while the extraordinary ray is transmitted. Thus, double refraction is seen to be closely associated with absorption, and the latter property has been found to depend on the free periods of the material particles set in motion by light waves. If we suppose that the vibrating particles of a doubly refracting crystal are arranged regularly, so that their periods of vibration are different for displacements which are respectively parallel and perpendicular to the optic axis, then it follows that waves will be transmitted with different velocities according to the direction of displacement in the wave front. This gives an explanation of double refraction, and the polarization of the transmitted rays. If the period of the

incident waves agrees with one of the free periods of the material particles, when vibrating in a particular direction, then the ray corresponding to this direction of vibration will be absorbed after traversing a small thickness of the crystal. See, also, **Polariscope** and **Polarization**.—(C. F. P.)

Tourmalin tongs. An optical instrument for exhibiting the polarization of light, or for examining substances in polarized light, consisting of two transparent plates of tourmalin, cut parallel to the axis, and mounted in circular pieces of cork held in a kind of wire pincers and between which the substance to be examined is placed. Formerly much used by opticians to detect whether a lens was made of Brazilian pebble or not. See, also, **Polariscope**.—(C. F. P.)

Tourner. (F.) To rotate.

Tournoiement. (F.) Vertigo.

Touroscope. An apparatus for viewing lantern slides and transparencies.

Tourtual, Kaspar Theobald. A well-known German anatomist, physiologist and ophthalmologist. Born at Münster Sept. 1, 1802, son of the well known German official physician, Karl Florens Tourtual, he received the medical degree at Berlin in 1823, presenting as dissertation "De Mentis circa Visum Efficacia" (published in Radius' "*Collectio Script. Ophthalmol. Minorum*, Vol. II). After further study at Paris and a number of the universities of Southern Germany, he taught at Münster for several years. He died May 15, 1865.—(T. H. S.)

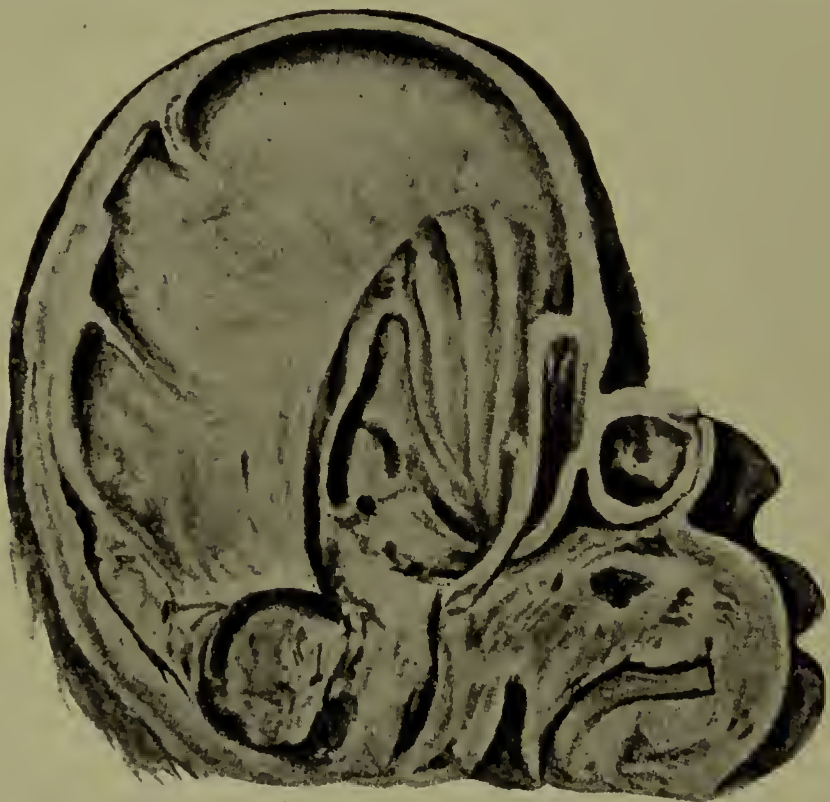
Tousey. (After Sinclair Tousey, New York röntgenologist.) A unit of x-ray power; being the radiance which will produce on a photographic film an effect equal to that produced by a one candle-power incandescent electric light.

Tower-skull. Steeple-skull. Oxycephaly. Steeple-head. Ox-head. Thurmschädel. Turritum caput. Scaphocephaly. Hypscicephaly. Acrocephaly. Tower-head. Under these various names this subject has been discussed, notably under **Oxycephaly, Ocular complications of**, p. 9207, Vol. XII, and on p. 3553, Vol. V of this *Encyclopedia*.

Both the principal types of this class of cranial deformity, *tower-skull* and *oxycephaly*, are conditions resulting from premature union of the coronal suture. In the latter case the cranial dome is insufficiently elevated and lateral extension takes place below; the temporal regions bulge and the zygomata protrude. Other structural changes occur, so that the orbital space is diminished in varying degrees,

influencing the amount and character of the *exophthalmos.* Some of the cases are undoubtedly hereditary. Deformity of the optic foramen and, possibly, pressure upon the nerve, are responsible for the optic neuritis and the postneuritic or primary optic atrophy. The illustration shows the relations of the bony parts in the oxycephaly case of Power (*Trans. Oph. Soc. U. K.*, Vol. 14, 1894).

Michael Goldenburg (*Am. Journ. of Ophthalm.*, Nov., 1918) discusses especially the *etiology of tower-skull* in respect of the eye symptoms. He finds, from the literature, that it is quite probable that malformations of the head are more commonly the cause of eye



Oxycephaly. Anteroposterior Section through Right Eye. (Power.)

lesions, than one is led to believe. To 1912 only 26 cases of tower head had been reported. Enslin (Virchow's *Archiv*, 58, 1910), who looked for these cases over a period of two years, out of 9,380 eye patients found 16 cases of this kind.

Tower skull, *per se*, as the cause of eye disease, is still problematic, for we find a number of cases reported of this shaped head, without any eye lesions at the time of examination.

In the 42 cases reported to date, 36 had post-neuritic atrophy, 2 double neuro-retinitis, 2 one-sided papillitis and post-neuritic atrophy, and 2 cases primary optic atrophy.

The question arises whether the tower skull is the direct or indirect cause of the optic nerve lesion. The theory propounded, that

the causal factor responsible for the malformation of the skull is also the cause of the optic nerve lesion, has a number of adherents.

That a prenatal osteitis is present, and is the probable cause of the premature ossification of the sutures, nearly every one is agreed upon. The etiology of osteitis, at least in adult life, is infection of some character. That a metastatic infection during intrauterine life is possible there is no doubt and is not strange to ophthalmology.

Enslin discovered six specimens of tower-skull with papillitis but could not demonstrate in them constriction of the optic foramina; he, however, states that this does not entirely detract from the com-

Goldenburg's Case Showing Prominent Eyeballs and Divergent Squint.

Side View Showing Peculiar Shape of the Skull.

pression theory, as the skulls he examined were very old and very dry.

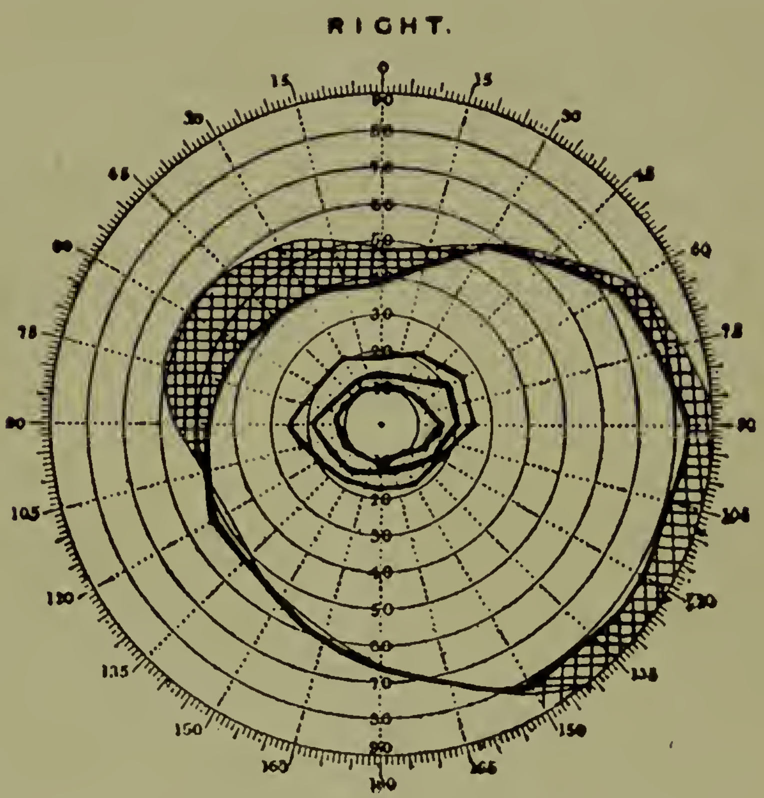
The factor of *hydrocephalus*, internal or external, as the cause of the eye lesion, *per se*, is of considerable importance. Whether this is a transitory form, as suggested by Friedenwald (*Archives of Ophthalm.*, 1901) or the result of premature ossification of the sutures, remains an open question.

In Goldenburg's patient the eyes (see the cuts) were very prominent and the child did not seem to show evidence of being able to see very much, as far as the mother can remember.

The child's well marked *tower skull* had a bitemporal circumference of 17¾ inches. A sagittal measurement of 14¾ from nasion to occipital protuberance. Perpendicular from nasion to highest

point of the skull of 5½ inches and an anterior-posterior diameter of 5½ inches.

The eyeballs were very large and the sclera thin; the cornea normal in size, transparency, and sheen; a divergent strabismus with a marked horizontal nystagmus; anterior chamber and iris negative. The pupillary opening was about 6 mm. and equal in both eyes; the pupils reacted very sluggishly to bright light. Tension negative. Vision in R eye = O. Disks a dirty gray and outlines not well defined; there was an uncertainty as to the caliber of the vessels, owing to the marked nystagmus, but the writer was inclined to think that



Field of Vision in Frank Allport's Case of Toxemic Retrobulbar Neuritis.

there was some evidence of a perivasculitis. Direct ophthalmoscopy was very difficult and unsatisfactory.

Roentgenographs showed the skull to be very irregular in thickness with numerous depressions on the inner table undoubtedly formed by the convolutions of the brain. Suture lines were not demonstrable; and the grooves of the meningeal vessels or diploic veins were markedly accentuated. The sella turcica was approximately normal in size. No evidence of changes responsible for the exophthalmos.

Toxemias in ophthalmology. The poisons that find their way to and infect the ocular tissues through the channels of the blood are numer-

ous and difficult of detection. Croftan (Wood's *System of Ophthalmic Therapeutics*, p. 247) believes that in consequence of this fact no specific (with the exception of a few of the bacterial toxemias), antitoxic treatment can, in the obscurity of our present-day knowledge, be instituted. The source, on the other hand, and the manifestations of these toxins are very well understood, hence a large and successful field remains for causal and symptomatic therapy.

The toxins may either be generated within the body (endogenous toxemia) or they may be introduced from without (exogenous toxemia). In the former case we speak of auto-intoxication and include under this name a group of symptom-complexes attributable in the main to a variety of dental, tonsillar, gastro-intestinal, hepatic and metabolic, scil-constitutional, disorders. The exogenous toxemias include all forms of poisoning due to unorganized bodies (alcohol, tobacco and other alkaloids, metallic poisons, etc.) introduced from without, and also intoxication by poisons elaborated within the body by parasites (bacteria, tænia, amœba, etc.)

Toxemic amblyopia. Although the essential differences between a *toxic* amblyopia and a *toxemic* amblyopia are ill-defined and mostly conventional, yet it is probably wise to mention that these distinctions are held by some authorities. See **Toxemias in ophthalmology.**

For example, Frank Allport (*Oph. Record*, Dec., 1912) reports a retrobulbar neuritis of *toxemic* origin. The fundus was normal, as were the accessory sinuses and nose; patient had a central scotoma. A diagnosis of retro-bulbar neuritis from intestinal toxemia was made, following a catarrhal jaundice. In ten days, patient was discharged and no scotoma could be obtained.

Toxic amblyopia. Amblyopia from drugs and other poisonous agents. Intoxication amblyopia. This section should be read in conjunction with such headings as **Amblyopia, Toxic,** p. 303, Vol. I, in which an introduction to the whole subject will be found and the treatment of the ordinary forms of the disease is given; **Amblyopia, Central,** p. 290, Vol. I, a common sign in this form of intoxication; **Blindness, Prevention of,** p. 1153, Vol. II, in which numerous sub-headings related to this subject are discussed; **Blue-green vision,** as a sympton of *carbon disulphide amblyopia;* **Chromatopsias,** p. 2199, Vol. III, occurring in numerous forms of the disease; **Conservation of vision,** pp. 3243-3262, where under the rubric *Whisky, tobacco, drugs and the eye*, a popular account of the more common forms of toxic amblyopia is given; **Rheumatism,** p. 11428, Vol. XV, as a source of toxic amblyopia; **General diseases and ophthalmology,** p. 5350, VII;

Legal relations of ophthalmology, especially p. 7133, Vol. IX, in which a number of oculotoxic agents are discussed; **Retrobulbar neuritis,** p. 11411, Vol. XV; **Optic atrophy,** p. 9059, Vol. XII; **Neurology of the eye,** where under the minor caption *Intoxication amblyopia,* p. 8341, Vol. XI, several forms of the disease are treated; **Medical ophthalmoscopy,** a section that, particularly under TOXIC STATES, p. 9047, records the fundus alterations in many forms of amblyopic and amaurotic intoxication; **Pupil,** especially p. 10761, Vol. XIV; **Cachexia pellagrosa,** p. 1351, Vol. II, in which the eye symptoms from diseased corn (maize) are described.

In addition to the foregoing references, and to the list that follows, this *Encyclopedia* furnishes the oculotoxic relations of a large number of agents of minor importance. These captions include many histories of doubtful value, that, consequently, have not been discussed in this section, although they will be found under their proper headings throughout the volumes. It may, also, be added that so completely have all the principal and most of the unimportant causes of toxic amblyopia been covered in this work that this section, if undue repetition is to be avoided, necessarily consists largely of references to other pages where these subjects have been examined.

In the preparation of the major and minor headings of this extensive and practical subject free use has been made of various monographs on the subject that have appeared during the past thirty years, and to them in particular the reader desiring to institute a more exhaustive research in the literature of the toxic amblyopias as a whole is earnestly referred. These chief sources of information are as follows: *The Toxic Amblyopias,* 1894, Casey A. Wood; *Toxic Amblyopias,* 1896, Geo. E. deSchweinitz; *Les Maladies des Yeux dans leurs Rapports avec la Pathologie Générale,* 1892, Emile Berger; *Die Beziehungen des Sehorgans zu den übrigen Krankheiten des Körpers,* 1893, Max Knies; and, last but by no means least, the exhaustive two-volume monograph of Lewin and Guillery, 1905-1907, *Die Wirkungen von Giften auf das Auge.*

Of the special monographs, Uhthoff's work on alcoholism and the human eye, published in Graefe's *Archiv f. Ophthalmologie,* Vol. 32, Pt. 4, and Vol. 33, Pt. 1, is worthy of mention. In it the pathological histology of the subject is elaborately discussed in the light of autopsic material.

An extensive bibliography is attached to the text in the books, both of deSchweinitz and Casey Wood.—(Ed.)

The expression "amblyopia," derived from the Greek *amblus,* dull, and *ops,* the eye, was in preophthalmoscopic days applied indiscriminately to any case of weak vision not explainable by known refractive error or by any apparent change in the structures of the eye. In this respect the term is no longer correctly applicable to a number of other conditions still commonly included within its scope. However, like such popular medical expressions as "primary" and "idiopathic," it serves a useful purpose in our semiscientific nomenclature.

Toxic amblyopia may be defined as an organic or functional reduction in visual acuity not dependent upon the refractive condition of the eye and induced by the introduction from without into the general bodily system (in some instances into the conjunctival sac) of toxic substances having a selective action upon the retina, optic nerve, optic tract, or optic center, or upon some other ocular structure in consequence of which the vision is temporarily or permanently reduced. Although this is much less comprehensive than earlier definitions yet it is commonly received by modern writers.

Classification. Attempts at the classifying of oculotoxic agents have not been very successful but two, both American, are here introduced.

Casey Wood (*loco cit.* p. 3) believes that the toxic agents which produce deterioration of vision may be roughly divided into two classes. The first comprises those whose toxic effects are generally known to present certain constant factors and to be associated with injury, more or less demonstrable, to the optic nerve and retina. The second group of poisons includes those substances that produce a weakening of sight for the most part of an acute and transitory character, unaccompanied by physical signs of tissue change in the optic nerve which entitle them to be included in the first class. The following classification is in some respects empirical, but for our purposes, it is a useful and necessary one.

CLASS I.—POISONS THAT DIRECTLY AFFECT THE OPTIC NERVE.

Division 1. Poisons that produce a chronic retro-bulbar neuritis—alcohol (ethyl and methyl); tobacco; alcohol-tobacco; carbon disulphide; haschisch; iodoform; arsenical compounds.

Division 2. Poisons producing other forms of optic nerve and retinal diseases—lead; quinine; salicylic acid and sodic salicylate; cocain; venom of poisonous reptiles; salts of silver; mercurical preparations; ergot; nitrite of amyl; nitrous oxide gas; male fern and pomegranate.

CLASS II.—POISONS WHOSE AMBLYOPIC SYMPTOMS ARE UNACCOMPANIED BY RETINAL OR OPTIC NERVE LESIONS.

Division 1. Agents that produce chiefly mydriasis—belladonna and its products; alkaloids from the datura stramonium; hyoscyamus niger: decomposed food; poisonous fungi; poisonous fish (ptomains: leucomains, etc.); sulphuretted hydrogen; carbolic acid.

Division 2. Agents that bring about a toxic state whose chief ocular sign is a contracted pupil. These are morphia and other preparations of opium; aconite (?); chloral and its hydrate; pilocarpin and jaborandi extracts; eserin and calabar bean.

Division 3. Poisons producing various or irregular eye symptoms—osmic acid; picric acid: santonin; digitalis; tea; chocolate; gelsemium; anilin dyes; nitro-benzol; emanations from pitch and coal; preparations of iron (?); iodin (?); arsenic; naphthalin; coffee (?); methylated spirits: ethylen chloride; sulphuric acid; potassic bromide.

The list of agents whose use, local or general, is said to have produced visual disturbances is, thus, a long one, but in some instances the accounts given of the alleged amblyopia are very meager or very indefinite, or they come as physiological experiments made upon the lower animals. In some other cases the amblyopia was plainly due to local, mechanical irritation of the conjunctiva and cornea, or, like the ordinary miotics, to mere contraction of the pupil with or without interference with accommodation. Lastly, in several instances will be found isolated references to ocular symptoms supposed to be produced by toxic agents which could not be traced, or when traced turned out to be entirely misleading.

The following classification has been adopted by de Schweinitz based upon leading physiological and toxic actions (*loco cit.*).

I. Drugs chemically diverse and, when given in physiological dose, producing greatly different effects, but when acting as chronic and sometimes as acute poisons, are capable of originating definite tissue changes and degenerations, including alterations in the blood:

Alcohol.
Amyl-alcohol.
Methyl-alcohol.
Tobacco.
Carbon bisulphide.
Iodoform.
Iodine and iodide of potassium.
Chlorate of potassium.
Nitro- and dinitro-benzol.
Benzine (petrol-ether).
Hydrocyanic acid and cyanide of potassium.
Nitrite of amyl and nitrite of ethyl.
Coal tar products, including anilin, naphthalin, safranin, fuchs-

in, etc., carbolic acid, hydracetin, picric acid.
Arsenic.
Lead.
Mercury.
Nitrate of silver.
Oxalic acid.
Phosphorus.
Osmic acid.
Chromic acid.
Sulphuric acid.
Ergot.

II. Drugs and chemical compounds which in full or toxic doses depress the cerebro-spinal axis or the peripheral nerves:

Chloroform.
Ether.
Ethyl-chloride.
Methyl-chloride.
Opium (Morphine).
Chloral.
Sulphonal.
Bromide of potassium.
Cannabis indica.
Curare.
Carbonic acid.
Carbonic oxide.

III. Drugs which are cerebral stimulants in physiological, and nervous depressants in toxic, dose:

Caffein.
Thein.
Chocolate.

IV. Drugs which in full dose reduce bodily temperature and in poisonous doses are nervous sedatives, and which may have selective influence upon the organs of special sense (ear and eye):

Acetanilid (Antifebrin).
Phenozone (Antipyrin).
Quinin.
Salicylic acid.

V. Drugs whose prominent action is concerned with the central organ of the circulation, acting either as stimulants or depressants:

Aconite.
Alcohol (included also in Class I).
Digitalis.

VI. Drugs whose chief effect on the eye is mydriasis:

Atropin.
Cocain.
Conium.
Daturin.
Duboisin.
Ephedrin.
Gelsemin.
Homatropin.
Hyoscyamin.
Hyoscin.
Scopolamin.

VII. Drugs whose chief effect on the eye is miosis:

Eserin.
Muscarin.
Pilocarpin.

VIII. Drugs whose medicinal use is concerned with the expulsion of intestinal parasites, but when acting as poisons are capable of originating diverse visual disturbances:

Filix mas.
Pomegranate.
Santonin.
Pink-root.

IX. Drugs and poisons not included in the former lists as possessing no definite actions worthy of special grouping:

Aesculin.
Apomorphin.
Chrysarobin.
Cystisin.
Menthol.
Sulphur.
Piscidia.
Podophyllin.
Saponin (from *Quellaga saponaria.* Also *Saponaria officinalis.*)
Sulphuretted hydrogen.

X. Ptomains. Meat, fish and sausage poison. Snake poison:

Ethyl-diamin.
Fungus poison.
Meat and fish poison.
Ptomains.
Snake poison.

SIGNS AND SYMPTOMS OF THE COMMONER FORMS OF TOXIC AMBLYOPIA.

Casey Wood (*loco cit.*) remarks that while we must regard the toxic agent as the direct or exciting cause of the visual failure, it must not be forgotten that there are a number of well recognized indirect or predisposing causes which favor the development of the disease.

In almost all instances of impaired vision where the exciting cause of the amblyopia is a drug in common use, whether as a medical remedy or not, there exists an *idiosyncrasy* on the part of the sufferer towards the agent in question. This also holds true, but to a less degree, in those cases where the poisonous agent is infrequently employed. How comparatively few persons suffer from impaired vision due to alcohol, tea, chloral or tobacco, and yet how universally are these agents employed! Nor is there any necessary relation between the amount of the poison absorbed and the amblyopia. Frequently one finds that the eyesight entirely escapes the effects of alcohol in topers living most of the time on the borderland of insanity, or who are continually reeking with the stale odor of chewed and smoked tobacco. On the other hand, a well marked amblyopia may be met with in persons smoking a couple of ounces of mild tobacco or two or three cigars a week. The exceptions to this rule are such drugs as the mydriatic poisons—belladonna, hyoscyamus, and the like—

which when taken in full doses almost invariably produce a temporary amblyopia.

One rarely sees tobacco, tobacco-alcohol or ethyl alcohol amblyopia in a patient under forty, notwithstanding the free use of these stimulants by persons under that age. The *vis resistentiæ* of youth seems to protect the nervous system from the degeneration which in old and middle-aged persons results as well from these as from other causes. In Uhthoff's first cases the alcohol and tobacco amblyopics were of the following ages:

28-30 years of age	4
30-40 " " "	30
40-50 " " "	46
50-60 " " "	39
60-70 " " "	18

According to T. des Planches lead amblyopia occurs most frequently between the ages of thirty and forty.

The *male sex* has a practical monopoly of amblyopic symptoms from these toxic agents. In Uhthoff's 125 cases all were men. An exception to this rule is found in lead amblyopia. Oliver feels certain that women exhibit a greater susceptibility to lead poisoning than men. Of 135 cases noted by him in the Newcastle infirmary 91 were women and 44 men. The influence of sex is, however, per se, very slight in the production of amblyopic symptoms from toxic agents. If women were to use intoxicants or were exposed to the influence of toxic agents to the same extent as men, visual disturbances might be as common from that cause with them as they are with the sterner sex. Of the cases of quinin amblyopia reported nearly one-half are females. The meaning of this is that the drug is used almost as extensively by women as by men. Chisholm relates an interesting case of tobacco amblyopia in a refined lady. The following history is a further illustration of this contention:

Amelia F., æt. 56, presented herself at the clinic of the Post-Graduate Medical School desiring presbyopic glasses. She gave the usual history of failing vision for near work and said that no glasses seemed to help her. She also stated that her distant vision had been "misty" for some time past. To drown domestic sorrows she drinks a pint of whiskey before breakfast and smokes 6 to 10 pipes of "Tip-top" tobacco daily; has typical central scotomata for red and green. Pupils contract well to light and accommodation. No fundus changes. VR and L = 6-60; with plus 1. D = 6-18. Can read Jaeger VI with near correction. Promised to give up alcohol and tobacco, but has not since returned.

Occupation has something to do with the liability to toxic amblyopia from tobacco and alcohol. As Berry points out, in the case of workmen, farm laborers and others, who rise very early and work a few hours before breakfast the temptation to smoke and drink on an empty stomach is great. This is also true of bartenders and saloon-keepers, who, in the course of business, feel obliged to consume at all hours numerous samples of their own wares.

The action of all forms of exhausting diseases—especially those that affect the nutrition of the body—in predisposing to the toxic action of nicotin and alcohol is too well known to need discussion here. They act just as poor and insufficient food does and for the same reasons.

Attempts have often been made to separate the signs and symptoms of tobacco amblyopia from those due to alcohol alone or to alcohol and tobacco combined. Poetseka, Foster and Hirschberg assert that such a differentiation can be made. Since, however, there are no reliable signs or symptoms whereby nicotin amblyopia can be distinguished from that due to alcohol, the symptomatology of the three forms of amblyopia will be considered under one heading.

The first symptom of which the patient usually complains is dim or "misty" vision. It is not to him so much a failure of sight as the sensation of looking through smoke or mist at distant objects. The visual failure grows gradually worse; it almost invariably affects both eyes and to the same extent. Monocular amblyopia from toxic agents is exceedingly rare, although Lawford and others have recorded such cases. The noticeable thing about the failure of vision from these intoxicants is that it never becomes absolute. One may state with certainty that complete loss of sight never happens in pure ethyl alcohol or tobacco amblyopia. In the Uhthoff cases it never sank below 6/200.

An early indication of trouble is the inquiry for stronger glasses with which to do near work. The sufferer finds, for example, that it is impossible for him to read as well as he previously did, even before he notices any marked defect in his distant vision, and naturally concludes that he requires a change of spectacles. And, for a time at least, strong convex lenses may assist his failing vision by producing larger images, especially if they are very strong and the print is held near the eye. As the disease progresses he discovers that he can not read ordinary print with any glasses; indeed, with the best glasses he may be able to read only Jaeger 6 or 8.

The amblyope rarely suspects the cause of his trouble, as he has probably not made any recent change in his habits, i. e., drinks about the same amount of alcohol and smokes the same number of cigars

or the same quantity of tobacco. The worry and anxiety attendant upon his impaired vision may indeed induce him to smoke or drink the more, but as that occurs after the amblyopia has declared itself, he does not think of the circumstances as likely to increase his troubles.

Color-blindness is a very common symptom and is confined, as a rule, to inability to distinguish green and red. The sufferer may not find it out until he has handed over a five-dollar gold piece or a two-cent piece for a nickel, or (in England) given a sovereign for a sixpence. An amblyopic patient with fair visual acuity used to complain that he was no longer able to delight his eyes with the sight of certain scarlet berry clusters on the mountain-ash trees near his home. Connor relates the case of a florist who found himself mistaking colors in making decorations with plants. The color of his red roses became dirty and he could no longer see to pick the worms off the bushes. Noyes speaks of an artist who complained that he was not able to produce upon canvas the brilliant reds that he once did.

This color defect is confined to the center of the field of vision. It is a negative scotoma so that the patient is not conscious of the defect as such. A red surface to him is all red.

Not infrequently amblyopic patients see better in dim than in bright light. One of Wood's patients complained most bitterly of a shimmering before his eyes like "heat rays rising from the ground in summer."

Most observers speak of a patient's better vision towards evening, but this is especially true of the early morning hours when the patient has been refreshed by a good night's rest and the light is not strong enough to contract the pupils. A patient of Wood, suffering from tobacco-alcohol amblyopia (with vision of 6/60), was obliged to arise before dawn. He said, without suggestion, that he could see remarkably well when he first got up, that his sight became obscured as the day advanced and then it partially recovered towards evening. Since toxic amblyopes see better with the perimacular parts of the retina than with the insensitive yellow spot, it is easy to understand that a dilated pupil will be of some advantage to them. The occasional use of very weak (gr. one-eighth to one ounce) atropin drops, as well as the wearing of tinted glasses, subserve the same purpose; the former keep the pupil in a state of dilation by paralyzing the contractor fibers of the iris, while the latter gain the same result by cutting off the bright rays of the sun.

The use of the ophthalmoscope sometimes reveals certain changes in the optic nerve and sometimes the disc is absolutely normal. In the latter case we may suspect from what we know of the morbid anatomy

of the disease that the atrophic changes have not advanced as far forward as the disc. The most constant sign is an abnormal pallor (sometimes exactly triangular in shape, singling out the macular bundles) of the temporal side of the papilla. Uhthoff observed this in sixty-three out of one hundred cases of central toxic amblyopia. In eight the neighboring retina was affected without decoloration of the disc, while the fundus was normal in twenty-eight cases.

In a patient suffering from alcohol-tobacco amblyopia, which Wood had an opportunity of observing in Lang's clinic at Moorfields, there was on the temporal side of the disc a well-marked atrophic crescent extending quite to the edge of the papilla, and resembling in form the extra-papillary crescent of myopia.

Alcoholic retinitis has been observed in a few instances. Edmunds and Lawford relate the following case: A man, æt. 49, suffering from alcoholic paralysis, but without complaint of defective sight, relative scotomata, diabetes, albuminuria or history of syphilis, was found during life to present most of the appearances of syphilitic retinitis. Death in six months. Microscopical examination showed widespread disease of the retina with absolutely no affection of the optic nerve bundles or of the trabeculæ. No edema or infiltration in nerve sheath. They quote Sharkey's case as the only other one where retinitis, due to chronic alcoholism, has been reported. They think the disease should be termed alcoholic retinitis, and the fundi of all chronic alcoholics should be observed for retinal changes. In this connection it might be noted that Uhthoff distinctly refers to alterations in the retina as examined ophthalmoscopically in a thousand cases of chronic alcoholism investigated by him. The appearances were those of a very slight neuro-retinitis, but without retinal hemorrhages, papillary swelling, etc.

Loss of pupillary reflex to light was noticed in one per cent. of Uhthoff's cases, and has also been remarked by others and shown to be due to one or other of these toxic causes alone.

It is at least questionable whether tobacco and alcohol are capable of producing *atrophy of the optic nerve,* although such a claim has been made by various observers. It is highly probable, however, that where a central amblyopia of toxic origin goes on to true atrophy of the nervous tissue the latter condition is an association merely and not a later stage of the former. See on this subject an admirable paper by Groenouw (Graefe's *Archiv*, Vol. 32, I, 1). There were of Uhthoff's 1,000 patients only two doubtful cases with absolute central scotomata and peripheral limitation of the field.

Lawford relates nine cases which were diagnosed by him as tobacco

amblyopia, but later on he found that either they did not get well under treatment or got worse. It may be remarked in this connection that his Nos. 3, 6 and 7 are certainly typical tobacco amblyopias, and it seems impossible that they could be otherwise; but in Nos. 1, 2, 4, 5 and 9 the peripheral field was contracted and the scotomata were unusually large, while in No. 7 nothing was said about the periphery of the visual field.

Much has been written about the relations existing between the optic atrophy associated with diabetes and that produced by toxic agents, and it has been claimed that the former is sometimes a later stage of the latter. From all that we know of both processes it would seem as if the glycosuria did sometimes predispose to toxic amblyopia, but true destruction of the nerve is the work of the diabetes alone.

Lippincott has published an interesting case where, after an attack of delirium tremens, atrophy of both nerves with deterioration of central vision, concentric limitation of the field and incomplete color perception were present. Later, complete recovery.

Central color scotomata form an almost invariable sign of the diseases belonging to Wood's Class I. In uncomplicated cases of tobacco and alcoholic amblyopia the colors affected are red and green; blue and white are probably not entirely affected. Quite otherwise is it with carbon bisulphide and wood alcohol where an absolute scotoma for white may occur.

The typical scotoma for red in the former instance is that of a small oval including the fixation point and extending almost or quite to the blind spot. Much difference of opinion exists both as to the shape assumed by these scotomata and as to the conclusions to be drawn from it. Pœtschka, Hirschberg and others, affirm that when the amblyopia is due to tobacco alone, the relative defect has a paracentral position, while that due to alcohol is more or less pericentral. Uhthoff, having this contention in view, found that in eleven cases of well-marked pericentral scotoma alcohol was the cause of the disease in seven cases, tobacco in one case and tobacco-alcohol in three cases. Of nine cases of paracentral scotomata he found two to be due to tobacco, three to alcohol and four mixed. In one case (V=15/200) the scotoma was sometimes pericentral, sometimes paracentral, and Uhthoff hence concluded that when the patient continued to fix the central spot with his fovea, a pericentral scotoma was pictured, but when he chose an extra macular portion of his retina for the purpose it was paracentral. If this be true, very little reliance can be placed upon the shape or relative position of these scotomata, so far as the diagnosis between tobacco and alcohol is concerned.

Wood points out that macular disease may sometimes be mistaken for central toxic amblyopia, as the following case will show: C. T. H., æt. 40, always been healthy, but for twenty years has been a hard smoker and lately consumed as much as a pound a month of "Lone Jack" (a medium tobacco), with a daily use of five or ten cigars. Limited use of alcohol. In April he had an attack of the grippe, from which he lay in bed for six weeks and was confined to the house for nearly three months. Ten days after the attack began he noticed that he was blind, and for sometime could not see the bowl of his own pipe while smoking. Then he got gradually better and as his strength returned, vision improved. When well enough to go out he could see large objects; could, for instance, distinguish men from women, but nothing more. There was additional improvement until August. On December 6th, V.R.=20/50; V.L.=20/100. At this stage his case was diagnosed as one of alcohol-tobacco amblyopia, and his smoking and drinking were stopped. He was given hypodermic injections of strychnia every morning until he was taking one-third of a grain. Examination showed in the R. E. a central scotoma for red, green, blue and yellow. White was seen as gray. There was the same condition in the left eye, the colors being clearer five degrees from the center and especially on the nasal side of the field. He had been using the strychnia for a month, but careful examination showed that there had been no improvement in vision. With + 1. L. E. J iv; R. E. J II, both very deliberately. A fundus examination revealed a whitish discoloration about the fovea centralis of both eyes and although the treatment with strychnia and abstinence from stimulants was kept up for another six weeks, no improvement in either distance or near vision occurred. A year afterwards the condition of the patient was unchanged.

Powers' test.—If a toxic amblyope be made to inhale a few drops of amyl nitrite and his vision be examined as soon as flushing of the face sets in, a temporary increase of visual acuity will be observed. This amounts upon occasions to as much as a rise from 20/200 to 20/50 or 20/40 and alone forms the most positive proof that the patient suffers from an affection whose visual defect is due to an anemic state of the optic nerve. Moreover, this affords a test of some prognostic value for it has been noticed that in those cases where the visual increase is marked a cure can be safely predicted in the near future. In one case (V.R.=20/100, V.L.=20/200), the effect of amyl nitrite was so lasting and gave so much relief that the drug was administered at regular intervals in addition to other remedies.

Contracted pupil.—It has been shown both by Schur and Rogow that the local application of nicotin acts like eserin in producing miosis, that is to say, a paralysis of the sympathetic nerve endings of the iris which allow the sphincter pupillæ fibres to act. This fact probably explains the contracted pupil so common in tobacco and tobacco-alcohol amblyopia. The blood and other nutrient fluids continually charged with nicotin, in quite the same way, exert a specific but quite local action. This is the opinion of Hirschler, who, however, attributes the contracted pupil, which he has noticed in pure alcohol amblyopes, to disease (probably fatty metamorphosis), of the medulla oblongata.

When all the symptoms of central amblyopia due to intoxicants are considered, it ought to be, and as a matter of fact is, easy to detect and differentiate these forms of ocular disease. Uhthoff thus summarizes the *points* of diagnosis between the retrobulbar neuritis of tobacco and alcohol and that due to other causes, as syphilis, disorders of menstruation, "cold," diabetes, etc. 1. The central scotomata are almost invariably confined to red and green; it is rare to find even blue affected and almost never yellow of white. 2. The scotomata and visual disturbances are bilateral. 3. Vision does not fall below 6/200. 4. The form of the scotoma is that of an oval which usually includes and stretches from the fixation point to the blind spot and lies above the horizontal meridian. 5. The vision becomes gradually less. 6. The disease affects men almost always. 7. Of more than 40 years of age. 8. Pain is noticed on extreme ocular movemnets in the essential retrobulbar neuritis of women, but is invariably absent in the toxic form.

PROPHYLAXIS AND HYGIENE OF TOXIC AMBLYOPIA.

Although this subject will be discussed under several other (individual) captions it may here be added that Casey Wood has (*loco cit.*) suggested that every practitioner should remember how large a number of the commoner drugs which he is called upon to use in daily practice, may, in some patients and under certain conditions, be hurtful to the eye, or may interfere with its function, and that he should not neglect these danger signals of disease when they display themselves and so diminish the dose or entirely stop the remedy.

Other precautions suggest themselves. It has been noticed, for instance, that most cases of carbon disulphid amblyopia occur during those seasons of the year when windows and doors are shut and ventilation is imperfect. It is imperative, therefore, that in rubber or other

factories, where this agent is employed, the strictest attention should always be given to devices for carrying off the volatile fumes and for their dilution with an abundant supply of fresh air. It should also be borne in mind the fumes of wood alcohol are positively dangerous to life and eyesight when breathed in close, unventilated rooms.

One of Delpech's patients designed the following apparatus for avoiding inhalation of carbon disulphid fumes: "In a chamber which can be freely ventilated through its two extremities, a horizontal board is fixed to the sides by two ends; from its anterior edge a board descends to the floor of the chamber; from its posterior rises a vertical plank, fourteen inches high; this is pierced by three pairs of apertures so arranged as conveniently to give passage to the hands and forearms of three workmen. From the upper border of this vertical plank a sheet of glass passes upwards, and forward, and allows the workers to see their hands. The closure of the chamber is completed anteriorly, so that the only communication between it and the remainder of the room is through the six circular apertures. These are protected by impermeable and supple india rubber, which fits closely to the wrists of the workers by means of bracelets. The workmen sit with their legs beneath the horizontal table. All the operations are carried on within the chamber. It is stated that no odor was perceptible, and that although the operations were slightly retarded they were not so to any inconvenient extent."

Workers in white lead factories should be especially careful to keep their hands and finger nails clean and free from the poison, and when engaged in dry mixing should wear respirators. According to Berger, in the large lead works of Ivry, near Paris, ideally conducted from a hygienic standpoint, the workmen never suffer from symptoms of saturnism.

Under the heading "Prevention of Industrial Lead Poisoning," the *British Medical Journal* (II, 1893, page 1345) has the following:

The Departmental Committee, appointed by Mr. Asquith to inquire into the white lead and allied industries, and to suggest any precautions necessary for the protection of life and health, has presented its report. The greatest change recommended is the exclusion of females from all direct contact with white lead. In some works this is already done, and it is believed that the total number of women who would be displaced if this recommendation was carried out would not exceed 600. Further, they recommend that no female under 20 should be employed in white lead works; that before employment women should be submitted to medical examination, and that in both sexes a medical certificate should be required after absence through illness before re-

turn to work. They recommend that women should be required to wear overalls and head-coverings, and special shoes and stockings, while engaged in certain parts of the works. With regard to the enameling of iron plates, the recommendations are very similar; and it is proposed that in color works, also, the employment of females and male "young persons" should be prohibited, and that in lead smelting these two classes should not be permitted to clean the flues; further, that nobody should be allowed to work in the flues for more than two hours at a time, nor leave afterwards before taking a bath. The provision of special lavatory accommodation is advised in color works, lead smelting, yellow lead, electric accumulator, turning and enamelling of iron hollow ware, and red and orange lead works, and in the last it is recommended that all persons employed should be submitted to a weekly medical inspection. In the case of white lead and the enameling of iron plates and hollow ware, the provision of a dining room is recommended. The report contains a large number of proposed regulations directed to prevent poisoning through dust or by want of personal cleanliness, specially adapted to the needs of each industry, and it is proposed that the usage which obtains in the case of accidents —a compulsory report to her Majesty's Inspector of Factories and the certifying surgeon of the district—should be extended to cases of lead poisoning.

If in popular works on personal hygiene, as well as in lectures and essays prepared by members of the profession for the guidance and enlightenment of the laity, certain facts connected with the loss of vision sometimes produced by indulgence in tobacco and alcohol were set forth (without the exaggeration which sometimes characterizes the statements of prohibition and teetotal enthusiasts) it would at least serve as a warning to smokers and drinkers to cease or to moderate the, to them, abuse of these stimulants. The medical man should warn patients (those over thirty years of age particularly), with dyspepsia or other diseases affecting nutrition, that their smoking and drinking are very likely to lead to loss of vision through disease of the optic nerve.

The assertion frequently made by Wood, that obscure ocular symptoms or a transient amblyopia often accompany the medicinal employment of our common drugs—quinin, salicylic acid, iodoform, cannabis indica, etc.—and the daily use of tobacco, alcohol, tea, coffee and chocolate, is worth bearing in mind as explanatory of occasional attacks of weakened sight.

TREATMENT OF THE TOXIC AMBLYOPIAS.

It is not intended to discuss, except very generally, the treatment of those concomitant troubles which so often afflict toxic amblyopes unless they have a direct bearing upon the visual failure. It need hardly be said that all the toxic symptoms should be treated together.

Whatever be the form of poison that has caused the amblyopia, it should at once be discontinued. To this general rule there are, however, some exceptions. When the physician discovers that his patient does not entirely abstain from the deleterious agent he must be content with regulating its amount and time of indulgence; and he will often better accomplish this by allowing him to take a definite quantity than by attempting to force him to go without it altogether. Hutchinson and others do not restrict the amblyope in the matter of beer or wine, if taken in moderation, but sternly forbid the use of all forms of tobacco. On the other hand, Minor found his patients made excellent progress toward recovery when no embargo is laid upon their smoking or chewing. The observation that total abstinence is not a necessary factor in treatment has been made by many observers. Hill Griffiths, for example, as well as Lawford and Nettleship refer to it. Still, one can not help believing that in such cases the patient recovers in spite of the poison and not in consequence of it, and from observation of the behavior of patients treated with and without a continuance of the intoxicant, a quicker cure is reached in cases of entire abstinence. Wood considers it desirable to impress the patient with the idea that the length of time necessary for a cure will to a large degree depend upon the extent to which he indulges in his old habits. If, however, it is thought desirable to allow the patient to continue his tobacco or alcohol or both, he should be given moderate quantities of beer or light wine, taken only after meals, and he should smoke (not chew) a small quantity of mild tobacco, or one cigar, daily, and always after eating.

Although under individual headings treatment will be further taken up it may be said here that in many forms of amblyopic intoxication and especially in those associated with retrobulbar neuritis, Casey Wood (*loco cit.*) believes that next in importance to avoiding the cause of the disease is the recovery of the systemic tone which is nearly always lost in toxic amblyopia of the first class. So far as possible a return should be made to a normal condition of health. Regulation of the bowels, selection of proper kinds of food, care in personal habits, etc., are of great importance. The digestive power is frequently weak and should be fortified by appropriate means.

Gastric catarrh or other form of dyspepsia is almost always present. Bitter infusions and tonics are nearly always of value, indeed, it is probable that, to the tonic effects of certain specifics used in this disease, most of their value is due. Out-door exercise will be useful to those of sedentary occupations. The use of Turkish baths has been highly recommended, and in alcoholic cases especially has a decided value. In these various ways a much needed supply of good blood is carried to the badly nourished optic nerve tissue.

Coming to the so-called specific remedies, preparations of nux vomica, strychnia particularly, are very useful, especially in pallor of the disc and when general toxic (nervous) symptoms are present. Decidedly the most effective method of exhibiting strychnia is by hypodermic injection, beginning with a small dose, say gr. 1/50 once daily, and gradually increasing it until dryness of the mouth, stiffness of the muscles of the jaw and jerking of the extremities are produced. Wood's practice is to order a fresh one per cent. solution (for easy determination of the dose) of the sulphate or nitrate, and, using the same medicine dropper to insure uniformity in the size of the drops, inject the solution once a day, gradually increasing the dose one or two drops until no further increase is tolerated. He then diminishes the dose one drop (1/100 gr.) daily until no reaction is produced, and thenceforth continues that quantity. In conjunction with the injection tonic doses of tinct. nucis vom. or liq. strychnia, combined or not with iron or quinin, are administered before meals.

Iodid of potassium is another useful remedy and to be given, like strychnia, in gradually increasing doses. When there is hyperemia of the disc or signs of edema this drug is to be preferred to nux vomica preparations.

On account of the temporary improvement induced by inhalation of amyl nitrite, that drug has been recommended by several observers, Deutschmann especially, but Wood does not believe that it produces any permanently useful effects.

Coursserant, de Wecker and others advise hypodermic injections of pilocarpin in tobacco-alcohol amblyopia.

The tonic effects of electricity should not be forgotten, and its use is attended with benefit in almost all cases of central amblyopia, although very little is known of its modus operandi. The interrupted galvanic current, in doses of from one to five milliamperes should be employed, the negative electrode to the eye and the positive to the nape of the neck, for a few minutes daily.

Potassic bromid was employed years ago in the treatment of the amblyopia from alcohol, probably on account of its beneficial effect

in other manifestations of alcoholism. Bull prescribed it in doses of 1 grm. to be gradually increased until as much as 8, 10 or 12 grms. daily are taken. The Italian medical journals from 1871 to 1880, and even later, contain enthusiastic references to the value of potassium bromid in amblyopia ex abusu.

Quinia sulphat has also had its advocates; still, it is not likely that it has a specific action, but produces its good effect indirectly, as a general tonic. Ponti employed it in 1873 and claimed for it special advantages.

Hypodermic injections of pilocarpin have been much used in alcohol-tobacco amblyopia. Coursserant asserts that immediate relief is given, that the cure is rapid and in every way satisfactory. He considers it especially valuable for poor people, who need their eyesight sooner than their more affluent neighbors! He presents a list of cases, all treated by this means, with the addition of abstinence, tonics, the use of tinted glasses and, sometimes, hydrotherapy. He claims that cures were made in from nine to forty-five days.

Wood believes that where one can have his patient under proper control, especially in a hospital, daily pilocarpin injections, beginning with 1/8 gr. and increasing the dose if necessary to produce marked salivation, are of signal advantage and do cut short the period of treatment. Of course the dose, the interval between the subcutaneous medications, as well as other details of treatment, must be varied to suit the individual case. He gives them early in the morning with the following remedial adjuncts: the patient does not rise for breakfast, but takes instead of that meal copious drinks of hot and weak lemonade after the injection. He is then wrapped in blankets, with hot bottles to his feet and allowed to sweat thoroughly for half an hour. The hot bottles and all but one blanket are then removed for another half hour. Then he is rubbed down, allowed to dress and takes a light breakfast. In the afternoon, after lunch, he may go about as usual.—(W. H. C.)

TOXIC AGENTS ALPHABETICALLY CONSIDERED.

Acetanilid. See p. 56, Vol. I, and p. 515, Vol. I of this *Encyclopedia*.

Aconite. In addition to the notice on p. 77, Vol. I of this *Encyclopedia*, it may be said that a genuine toxic amblyopia from this poison is rare, although F. H. O'Brien (*N. Y. Med. Record*, p. 128, 1887) and others have mentioned cases. In the former instance miosis and twitching of the lids followed a poisonous dose.

Agaricus muscarius. Muscarine, the alkaloid of the *Agaricus muscarius*, and also existing as a ptomain in putrid fish, produces marked cramp of the accommodation and afterward myosis. In this sense it has the power of disturbing vision.—(de Schweinitz.)

Alcohol, Denatured. This industrial alcohol—the official form in the United States—resembles the British *methylated spirits*, and in both cases although they are imbibed (in spite of their nauseous odor and taste) by the hardened drunkard to some unknown extent, rarely produce amblyopia. Eleonskaia (*Oph. Year-Book*, p. 220, 1916) has commented on the extreme frequency of poisoning from denatured alcohol in the Petrograd hospitals since the sale of liquor was forbidden. Of 1,432 treated during 1915, 6 per cent. suffered from amblyopia. Half drank denatured alcohol, while others mixed cologne water or furniture polish. It required three or four months, and large quantities of the drug for the onset of the visual disorders. In general the disturbances are milder than those brought on by pure wood alcohol, but they are more severe than those from plain alcohol.

See, also, *Methylated spirits*, and *Alcohol, Methyl* in this section.

Alcohol. Ethyl alcohol. Grain alcohol. In addition to the remarks on p. 213, Vol. I; p. 2200, Vol. III, and p. 8345, Vol. XI, it may be pointed out here that notwithstanding the assertions of some authorities, there can be no doubt but that the drinking of this poison is one of the most frequent causes of toxic amblyopia. Deficient vision from abuse of alcohol has been recognized by the earliest writers on the subject. For example Plenck (*De Morbis Oculorum*, p. 175, 177), among the cases of amaurosis gives prominence to *abusus spirituosorum.* Not to mention the exhaustive treatise of Uhthoff, (Graefe's *Archiv* Vols. 32 and 33), in late years, the reader will find the case for alcohol argued at length in Doebbelin's thesis, published in 1850.

It is probable that the more dilute forms of alcoholic beverages taken in moderation (two or three glasses of beer or wine daily) alone rarely or never produce chronic amblyopia. Hutchinson thinks that the impurities in and additions to spirituous liquors may be held accountable for a large part of the damage to sight, but it has yet to be established that such adulterations as amylic alcohol (fusel oil, potato spirit) and the empyreumatic oils, or such ingredients as are commonly added to alcoholic liquids to form the liqueurs (wormwood in absinthe, hydrocyanic acid in maraschino, oil of juniper in gin, and so on), as well as the elaborate concoctions known as "fancy drinks" are, *per se*, capable of producing the characteristic symptoms of the disease. It is well established that long continued and frequent

indulgence in small quantities of spirits is more deleterious to eyesight than occasional "sprees." The persistent morning nausea, anorexia, muscular tremors, sleeplessness, and dull headaches that plague the chronic drinker are more likely to be associated with degeneration of the optic nerve tissues than are the more acute troubles of the deep but occasional drunkard. Of a 1,000 cases of decided alcoholism, Uhthoff found that 6 per cent. of them were sufferers from amblyopia; in 6.5 per cent. more he found optic nerve changes without amblyopia; in 5.3 per cent. pathological states of the optic nerve and retina, and in 12.2 per cent. other diseases of the ocular apparatus. So that 300 of these 1,000 chronic alcoholics had eye affections of one kind or another.

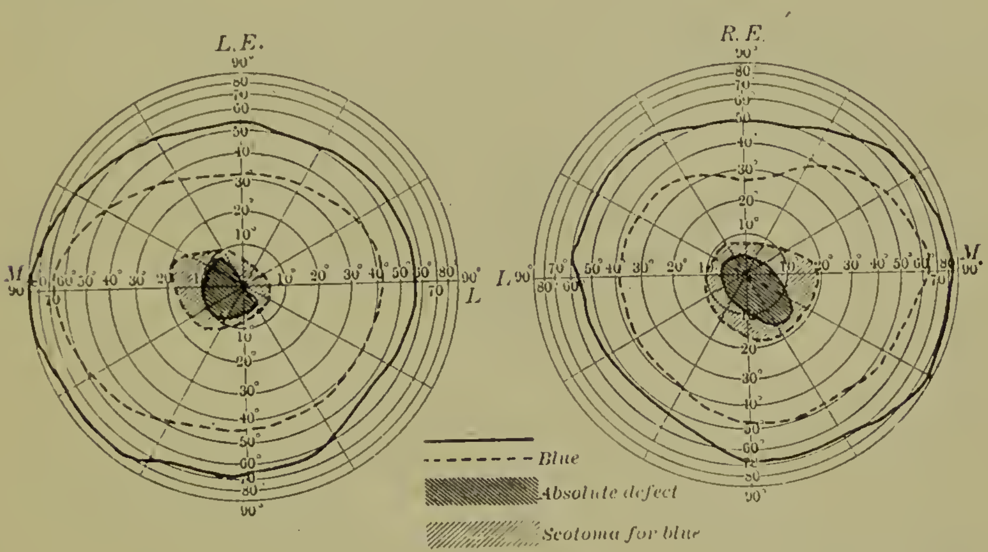
The *ocular symptoms* of alcohol amblyopia are according to de Schweinitz (*loco cit.*, p. 29) who quotes Uhthoff: Pathological whiteness of the temporal half of the optic papilla; occasional haziness of the nerve-head or hyperemia of its surface: rarely, retinal hemorrhages, and then only in connection with other symptoms, for example, convulsive seizures.

The pathological whiteness of the temporal half of the papilla, or sometimes only of a quadrant in the lower and outer portion, is the most frequent sign, and occurred in 13.9 per cent. of the cases examined by Uhthoff; sixty of these patients had amblyopia. Comparative examinations among lunatics and healthy people, the influence of alcohol being excluded, showed this phenomenon to be present only in very rare instances.

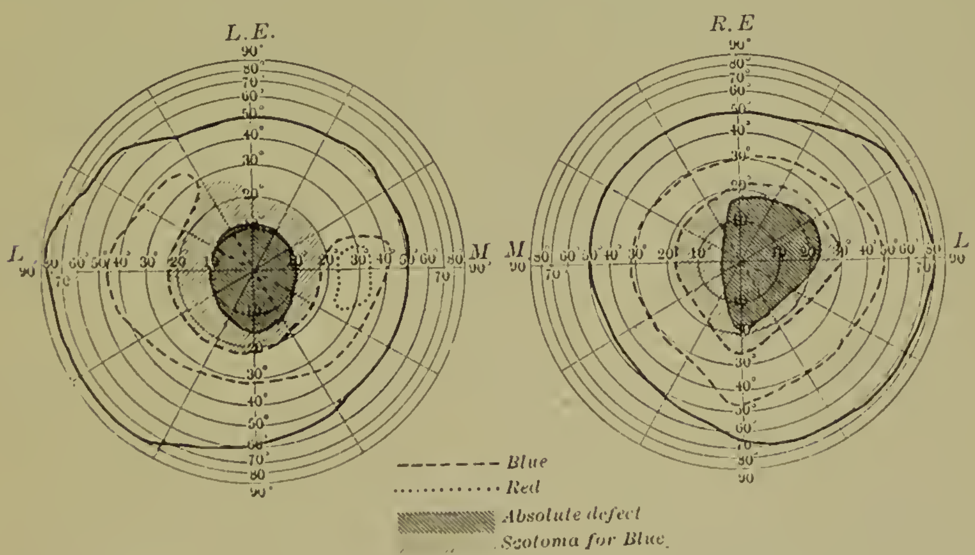
In the earlier stages a relative scotoma for red and green is present in the field of vision. Sometimes complete or partial peripheral defects for the same colors are present. In rare cases there may be a small central scotoma for blue, and exceptionally there are small absolute central scotomata surrounded by a blue-blind zone, and more peripherally by a red-green-blind region, the periphery for white being normal. These are the defects of the visual fields, according to Uhthoff, in toxic amblyopias.

Casey Wood (*loco cit.*) believes that the *mixed or alcohol-tobacco* type is much the commonest form of tobacco or alcohol amblyopia. He adds that the steady drinker is almost always a tobacco devotee and it is difficult to say which poison is, in such cases, responsible for the amblyopic symptoms. It may, however, be assumed that when the disease is found in a patient who drinks beer or light wines, but who smokes or chews some form of strong tobacco, the latter is probably the cause of his troubles. On the other hand, the infrequent smoker of mild tobacco (cigars and cigarettes especially) who regu-

larly takes spirits of any kind may be set down, even in the absence of other proof, as amblyopic from the drink habit. Hutchinson and other English writers claim that moderate drinkers of mild alcoholic beverages are less likely to be the subjects of tobacco amblyopia than total abstainers.



Alcohol-amblyopia. Small absolute central defect, surrounded by a scotoma for blue. (*Uhthoff.*)



Alcohol-amblyopia. Unusual type, illustrating large absolute central scotoma, surrounded by a scotoma for blue. (*Uhthoff.*)

To give an idea of the frequency (in America) of these cases as compared with other causes of anemic and atrophic states of the optic nerve the tables of Alt may be quoted. Of 120 such cases he found that tobacco alone was the cause in nine instances, alcohol alone in three cases, alcohol-tobacco in 39 cases. That is to say, in

more than 42 per cent. of the whole number of cases, tobacco and alcohol played the chief etiological role. Uhthoff's figures (30,000 patients), of course, refer to Germany. Of 204 cases of retrobulbar neuritic affections he puts down abuse of alcohol as producing the disease in 64 cases or 31 per cent., alcohol-tobacco in 45 cases or 22 per cent., tobacco alone in 23 cases or 11 per cent. Thus alcohol and tobacco, alone and together, were the cause of the neuritis in 132 instances—64 per cent. of the whole. In France, Galezowski has given some very interesting statistics based upon his observation of more than 20,000 patients suffering from diseases of the eye—statistics which fuller and later experience has confirmed. Of 151 cases of toxic amblyopia (tobacco and alcohol) only 21, fourteen per cent., were due entirely to tobacco. These were all heavy smokers, using from 20-80 grammes of tobacco daily or smoking 8-26 cigars. One-half per cent. of all the cases in the Hirschberg klinic had toxic amblyopia.

Wood concludes of all these forms of amblyopia that: 1. Both tobacco and alcohol, alone and combined, may produce toxic amblyopia. 2. It is probable that it is the nicotin in tobacco that produces the toxic effect. If this be true, chewing is more injurious to sight than smoking, short pipes than long ones, old or unclean ones than new or easily cleaned pipes, mild cigars and cigarettes than strong cigars, and strong tobacco than mild. 3. The form in which alcohol is taken into the system has much to do with the amblyopic effects. The lighter forms of alcoholic beverages, unless indulged in to great excess, do not permanently affect vision. The same quantity of alcohol which when diluted (as beer or light wine) would be harmless, might be injurious to the eye sight if taken in the concentrated forms of whiskey, brandy or gin. This is especially true when the latter are drunk between meals or when the stomach is empty.

The pathology of alcohol amblyopia. The discovery was made in 1882 by Samelsohn, of Cologne, from an examination of the optic nerve of an amblyopic patient, and confirmed in the same way by Lawford and Edmunds, Nettleship and Edmunds, Uhthoff, Sachs and others, that the essential lesion in this disease is an axial interstitial neuritis, beginning somewhere between the papilla and the brain and probably extending thence towards both the center and the periphery. As was suspected by the earlier authorities it is the fibers that supply the macular region (one-fourth or one-third of the whole) that are affected: the others generally escape. Although such a conclusion might with almost perfect certainty be prophesied from the fact that central negative scotomata are nearly always constant factors in the

disease, yet the confirmatory evidence of autopsies was needed. From these post-mortem observations (thirteen to the date of the report) we may conclude that the fibers supplying the fovea centralis and surrounding macular region, when they appear at the papilla, form a wedge-shaped sector and lie on the temporal side of the optic disc.[1] After reading the description of the various autopsies referred to, which are given with elaborate preciseness by the various writers, one is forced to the conclusion that the course of the papillo-macular fibers is not an invariable one in every individual. From what we know of the variations in size of the negative scotomata, the nervous degeneration is not strictly limited to this or that particular bundle supplied to the macular region. In Uhthoff's work reproductions of the microscopical sections are given showing the relation of the diseased (papillo-macular) bundles to the healthy nerve fibers in their course from the tractus opticus to the disc. This course corresponds very closely to that found by Uhthoff in a case of absolute central scotoma, the result of tabes dorsalis.

As to the form of the neuritis it must be remembered that the axis cylinder and the true nervous elements of the opticus escape; the resulting atrophy of them is a simple and not a numerical one. Indeed, one of the strongest arguments that is urged in favor of an alcoholic origin for many of these cases of central amblyopia is that we find in the optic nerve almost a typical picture of the havoc which alcohol plays in the tissues of other organs, namely, a morbid increase in the connective tissue element of the organ. The trabecular fibers, increasing as to number and size, press upon the true nervous structures and cause their atrophy, just as they effect the atrophy of organic elements elsewhere.

In Stiltzing's case (*Archives of Ophthalm.*, p. 233, Vol. 23, pt. 2) there were marked new vascular and connective tissue formations with abundant increase of nuclei in the interstices. The meshes were diminished in size, a portion of the nerve fibers being atrophic, the nuclei present being closer together than normal, but not numerically hypertrophied.

In much the same way, allowing for differences in structure, are brought about the cirrhosed liver, the fibroid phthisis and the peripheral multiple neuritis of drunkards. If multiple peripheral degenerative neuritis occur in other nerves from alcohol, why not

[1] For example, see Paul Bunge's *Ueber Gesichtsfeld und Faserverlauf im optischen Leitungsapparat*, Halle, 1884, and H. Wilbrand's *Die hemianoptischen Gesichtsformen und das optische Wahrnehmungscentrum*, Wiesbaden, 1890, both with colored plates and diagrams.

also in the optic nerve? Many instances might be quoted where degenerative changes in peripheral mixed nerves have occurred as a result of chronic alcohol poisoning. Lilienfeld has described a case of alcoholic paralysis of both nervi abducentes and of other peripheral nerves. Hadden found, post-morten, in a very intemperate man, 56 years of age, afflicted with alcoholic paralysis and dead of an intercurrent disease, "most advanced changes in the musculo-cutaneous nerves of the legs, wherein numerous empty and collapsed nerve tubes were seen, the granular material having disappeared."

Oppenheim gives five cases of alcoholic paralysis, but none with affections of vision.

Lancereaux (*Gazette des Hôpitaux*, p. 361, 1883) found, post-mortem, in a chronic alcoholic female, 48 years of age, with paralysis of the extremities, normal nerve centers, but lesions of the peripheral nerves. These consisted of an advanced granulo-fatty degeneration of the nerve fibers.

One of the most instructive cases, where atrophy of the opticus occurred with peripheral neuritis elsewhere, is recorded by Myles Standish (*Boston Med. Surg. Journ.*, Ap. 20, 1886) as follows. Man, seen by writer in September, 1884, a well marked A.-T. amblyope 52 years of age. Vision grew slowly worse, until he could barely distinguish people on the street. Finally V. = perception of light, and there was pronounced gray atrophy of the discs. He then passed through all the phases of multiple peripheral neuritis affecting the lower extremities, with pronounced mental symptoms, atrophy of leg muscles, etc. In September, 1886, he had improved so that he could walk up and down stairs. V. = 1/10, but memory impaired and absent knee jerks. Field of vision nearly normal and no color scotomata. Blue-gray atrophy and small vessels.

Standish collected forty-four cases of alcohol paralysis with reference to the eye symptoms and found that in seven there were no fundus changes; ten had congested discs; four white discs and two had discs white on the temporal side; three had large pupils that reacted slowly to light, i. e., 43 per cent., at least, had definite eye symptoms. The writer thus ends his interesting article: "The association of a multiple peripheric neuritis, the pathology of which is known, with a toxic amblyopia, the pathology of which is unknown, is particularly interesting and it does not seem improbable that the morbid processes may be identical. In both diseases the tendency of the disease is to recovery if the use of the toxic agent can be prohibited."

Sachs (*Archives of Ophthalm.*, Oct., 1894) in an exhaustive study

of this whole subject, emphasizes the resemblance, first pointed out by Samelsohn, between the ravages produced in the optic nerve by poisons of Class 1, Div. 1 (Wood), and those changes that mark the cirrhotic liver. "In both diseases," says he, "the process affects the interstitial connective tissue and in both the essential tissues of the organ (nerve fibers and hepatic cells) suffer, secondarily from pressure upon them. The analogy may be carried still farther. The areolar hyperplasia and cellular infiltration, characteristic of interstitial hepatitis, do not bear any constant relation to one another and are not dependent upon one another. In the same way, as shown in the microscopical examination of the optic nerves, the areolar hypertrophy and the cell proliferation appear to be entirely independent of each other, the latter being generally conspicuous by its absence. It is unlikely that a widespread cellular infiltration could precede the connective tissue hypertrophy without showing unmistakable evidence of its existence. * * *

The remarkable increase in the number of the neuroglia cells within the diseased bundles is also noticed by Samelsohn. If one accepts Edinger's theory of the epithelial origin of the neuroglia (*Zwölf Vorlesungen ueber den Bau der Nervösen Centralorgane*, 1892, p. 31) it would not be improper to compare this process with the commonly observed proliferation of epithelium within the bile ducts. At any rate one effect of this tissue change is to compress and injure the nerve fiber bundles themselves.

The parallel between hepatic cirrhosis and neuritis interstitialis is still more striking when the vascular changes are noted. These frequently occur in the first mentioned affection and consist of endothelial proliferation resulting in thrombotic closure of some vessels, occurring side by side with new vascular formations.

Sachs believes that the process, in his case at least, began not simply in the usual situation (the distal part of the nerve near the chiasma) but as a proliferating endophlebitis of the vena centralis postica, occasioning its obliteration and the formation of new capillary blood vessels in its neighborhood.

He thinks, with the English school, that in the mixed cases alcohol merely predisposes to the amblyopia by producing dyspepsia—in the form, usually, of a chronic gastric catarrh—and so interfering not only with the digestion but also with the assimilation of the food. He further believes that the normal gastric juices undergoing secondary changes of the fatty acid variety, form complex chemical combinations with nicotin, etc., which are either more readily absorbed into the system or are with greater difficulty eliminated from it. The

evidence of such abnormal changes occurring in the stomach he finds in the acetone odor with which the breath of patients is laden, and compares the condition to that of diabetic-tobacco amblyopes whose urine contains butyric acid. In answer to the argument in favor of alcohol as against tobacco (in bringing about the optic neuritis of toxic amblyopia) that while the former is known to produce changes (peripheral neuritis, atrophy, paralysis, etc.) in other portions of the nervous system these effects have never been shown to result from the abuse of tobacco, Sachs adduces the clinical evidence, the rarity of pure alcoholic amblyopia and the fact that the changes in the nervous system set up by alcohol elsewhere are unlike those found in the optic nerve in the mixed cases. When the ocular apparatus is affected in pure alcoholics the eye muscles, i. e., their nerve supply, and not the optic nerve are most likely to suffer.

Horner goes still further. He is convinced that neither alcohol nor tobacco, as such, produces the pathological changes in the opticus. They act by inducing gastric catarrh and so interfere with the general nutrition as to bring about such alterations in the nerve that follow certain cases of anemia, chronic discharges, etc. However, the rarity of retrobulbar neuritis in chronic dyspepsia not associated with alcohol, as well as its infrequency in cancer, tuberculosis and similar affections form a strong argument against Horner's extreme views.

The pathology of the central (red, green—sometimes blue and white) scotomata in diabetic smokers and drinkers is not clearly defined. That these defects occur in the diabetes of strictly temperate patients is undoubted and the fact seems to confirm Horner's views of the causation of alcohol-tobacco amblyopia generally, since the impression remains that the central defects flow from the malnutrition attendant upon the glycosuria rather than upon a special intoxicant. This may be said with some degree of certainty: When the central field for blue or white is affected the neuritis is of glycosuric origin and the prognosis is grave, i. e., the case usually goes on to simple atrophy.

On the other hand, and in view of the fact that tobacco does not produce visible organic changes in nerves elsewhere,[1] it is thought by some that the orbital neuritis of toxic amblyopia can not be due to nicotin. Hirschberg believes, at any rate, that tobacco may so affect the smaller retinal vessels supplying the macula as to produce

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1 A few observers claim that it does. In an article contributed to the *Recueil d'Ophtalmologie,* 1885, page 98, Jan records a case of unilateral paresis of the third nerve in a man 42 years of age, otherwise healthy, but addicted to the inordinate use of tobacco. The author argues that this can only be an instance of peripheral nicotin neuritis.

an ischemia of that region. Berry also denies the theory of a retrobulbar neuritis, believing that the poisonous effects of tobacco are expended on the cerebral origin of the papillo-macular fibers and postulates a common center for these in the brain. As an opportunity for an examination of the whole course of the optic nerve in toxic amblyopia rarely occurs, and since not more than a few cases of pure tobacco or alcoholic amblyopia have thus far been examined, one cannot state positively in what respect, if any, the lesions in the "pure" cases differ from the mixed cases referred to, or how they differ from one another. A priori reasoning would lead us to believe that the organic changes are practically the same in all cases of toxic amblyopia of which relative scotomata form a prominent symptom. But this certainly needs confirmation, not only in respect of tobacco and alcohol alone, but in the amblyopia due to carbon bisulphide, cannabis indica and iodoform.

Sachs calls the fibers that first undergo degenerative changes and from which these spread to surrounding parts the "nuclear group" ("Kern-gruppe") as it is here that the most destructive and best marked alterations are almost always to be found. These proceed until the papillo-macular bundles are affected; but the morbid process does not reach such a high degree in the latter, and thus it is easy to understand why an absolute defect is never found centrally and why the disease in this region is usually reparable. The alterations do not affect the nerve fibers themselves but merely the areolar septa, in the form of hyperemia and edema, so that the true nervous tissue enclosed by the former is merely temporarily injured. Thus the curability of a recent amblyopia may be looked for with certainty.

Regarding the anatomical explanation of that important ophthalmoscopic sign in tobacco-alcohol amblyopia, decoloration of the temporal half of the papilla, Sachs (q. v.) says:—"The physical explanation of this condition has not hitherto been sufficiently dwelt upon. Gowers considers it as due to a disappearance (atrophy) of the capillary vessels and a reduction of the red element in the normal color of the disc.

"Of more importance and easier of demonstration is the influence of the atrophy on the coloration of the papilla. The contraction of the areolar spaces of the lamina cribrosa and the marked aggregation of their trabeculæ, in consequence of a diminution in size of the nerve bundles that pass between them, must increase the quantity of light reflected from the anterior surface of the lamina itself. Moreover the thinning of the overlying nervous layer contributes largely to the same result. This phenomenon is really a 'contrast' effect, the re-

maining area of the papilla being either of the normal reddish color or made still redder by a hyperemic condition often present.

"The histological changes seen in sections of the nerve trunk, on both sides of the point of entrance of the retinal vessels, differ from those found in the latter region in that in the former the hypertrophied connective tissue is unaccompanied by cell proliferation, while at the vascular entrance the alterations present inflammatory changes within some of the bundles and about some of the vessels."

The correspondence of the temporal triangular wedge to the papillo-macular bundles of fibers is beautifully confirmed in a case reported by Knapp where, in an absolutely temperate girl, 18 years of age, a coloboma of the macula lutea, with the usual opticus sector plainly atrophied, was discovered by the ophthalmoscope.

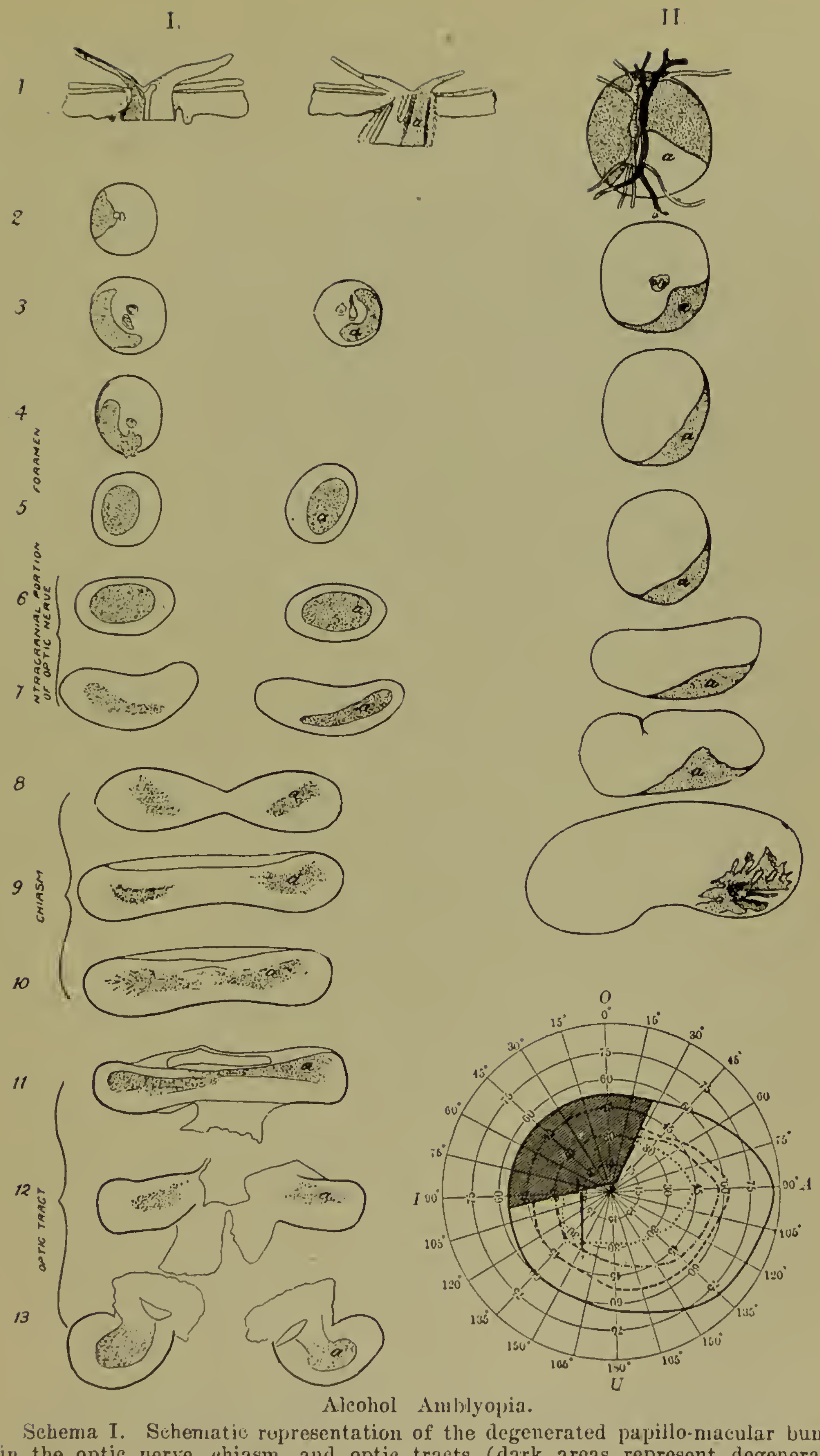
deSchweinitz sums up by saying that most of the investigations show that the anatomical basis of this affection consists of an augmentation of nuclei, hypertrophy of the connective tissue, and wasting of the nerve fibers of a limited portion of the optic nerve known as the papillo-macular bundle: in fact, that there is an interstitial, sclerosing inflammation comparable, according to Samelsohn, to the same pathological process which alcohol produces in the liver, for example, an interstitial hepatitis.

As de Schweinitz also points out, attempts have been made to differentiate between pure alcohol amblyopia, pure tobacco amblyopia and the visual loss resulting (apparently from indulgence in both poisons). According to Hirschberg (*Volkmannsche Vorträge*, p. 29, No. 246) the central defects are *pericentral*, and the oval scotoma is not of oval shape, passing from the fixation point to the blind spot, but other observers have not been able to substantiate this claim.

In spite of the demonstration by Uhthoff and others that the primary lesion in the commoner forms of toxic amblyopia is to be found in the axial optic fibres, Nuel and Holden have more recently held that the first change is really a *chromolysis of the retinal nerve-cells,* which goes on until the latter are destroyed. The optic alterations are by these observers regarded as secondary to the retinal lesions.

The *prognosis* of alcohol amblyopia depends upon the extent of the organic damage done to the nervous system (especially the optic nerve), the liver, kidneys, etc., as well as to the degree that the patient abstains from alcoholic indulgence.

Of *additional cases of ethyl alcohol amblyopia,* Friedman (*Journ. Am. Med. Asscn.*, Nov. 23, 1912) injected 25 c. c. of pure 90 per cent. ethyl alcohol into a sinus in the chest. In a few minutes the patient became unconscious and paralyzed in both upper and lower extremi-



Alcohol Amblyopia.

Schema I. Schematic representation of the degenerated papillo-macular bundle in the optic nerve, chiasm, and optic tracts (dark areas represent degenerated portions), according to Case I. of Uhthoff's series. Schema II. Schematic representation of the course of the nerve fibres in the optic stem, which comprise its lower and outer portion, and which when degenerated produce a quadrant defect in the visual field, upward and inward—tabes dorsalis, Case 7 of the series. (*de Schweinitz*, after *Uhthoff*.)

ties. Quickly regaining consciousness he complained that he could not see. His pupils were moderately dilated, and reacted to light. He could distinguish light from darkness. In one-half hour the motor paralysis disappeared. Amaurosis was complete for about an hour. At the end of four hours he could distinguish objects fairly well, and the sight was perfectly regained in three days. The ophthalmoscope showed only "slight congestion" of the fundus.

Kaiser (*Münch. Med. Wochenschrift,* No. 46, 1912) in reporting a case of ethyl alcohol poisoning with amblyopia, acknowledges that at first there must always be a suspicion of accidental wood alcohol poisoning. The patient, who was a man 53 years of age, had consumed enough spirits to produce delirium and hallucinations with tremor. During the hallucinations snow appeared dark and dirty, and upon plain white paper he saw colors and objects. Polyneuritis developed but the optic nerve was not involved. The field was greatly contracted without central scotoma. There was improvement in the fields followed by a temporary relapse. Vision was not permanently affected. Kaiser considers the condition as due to a sudden injury to the fibers of the optic nerve by drinking a very large amount of spirits within a short time.

J. N. Roy (*Canadian Med. Journ.,* Oct., 1912) reports a serious meningitis, choked disc and multiple polyneuritis of cranial nerves in a case of a young alcoholic smoker.

Iwanow (*Oph. Year-Book,* p. 239, 1913) conducted a series of animal experiments to determine the effect of ethyl-alcohol poisoning in endogenous infections of the eye. His conclusions are that alcohol poisoning favors the production of endogenous microbic infection of the eyes. It is more harmful than hunger, as the result of the paralyzing effect upon the vasomotor center (in acute) and through the changes in the endothelium of the vessels of the eye (in chronic) poisoning. At times severe inflammation of the eye is observed (leukocytosis and tissue destruction), which is more pronounced in acute poisoning. In chronic poisoning the changes are at times relatively unimportant fibrocellular, at other times the effect is severe and borders on purulent inflammation, microbes being present, but intracellular and free. This seems to rest upon a lowering of the phagocytic activity of the leukocytes. The organisms attack principally the anterior segment of the globe, chiefly through the vessels of the ciliary process; rarely also in the posterior segment, through the retinal and choroidal vessels. The clinical picture of endogenous infection of the eye does not always correspond to the anatomico-pathologic changes.

Hilbert (*Klin. Mon. f. Augen.*, Feb., 1913) supplements his essay on the pathology of the color sense by reporting a case of xanthopsia in a young, neurasthenic man, who, after an alcoholic excess, complained for three hours of seeing yellow.

The *treatment* of this form of toxic amblyopia is almost identical with that of *tobacco amblyopia* (q. v.).

Alcohol, methyl. Wood alcohol. Columbian spirits. Pyroligneous spirit. The amblyopia and amaurosis from this poisonous agent have been pretty fully described on p. 215, Vol. I; on p. 1158, Vol. II, as well as on p. 3253, Vol. V, of this *Encyclopedia.*

The importance of this subject demands our attention and to some extent a repetition of the facts indicated above, in view of the recrudescence of methyl alcohol amaurosis, indirectly due to Federal prohibition, reports of which are (1920) coming in from all parts of the United States.

Looking over the literature of the subject since 1907 we find that Gifford (*Prac. Med. Series,* Eye, p. 121, 1907) described the first case of methylic alcohol blindness from inhalation of rebreathed wood alcohol vapor in a confined space. The patient was, for about four hours, engaged in staining and shellacing the inside of a closed room, 16x14x8. Wood alcohol formed a large part of the material he was using. Two hours after leaving the room he was absolutely blind. He was well in every other way. Perception of light began to return in a week. In three weeks he could read coarse print. Then began a change for the worse, and in six months he was practically blind again. Then another change for the better began (considered by Gifford quite remarkable), and in the course of a year his vision was fingers at one foot in one eye and at six inches with the other, where it has remained. Optic discs are atrophic, vessels small, one-third of the temporal half of the right field remains, and the temporal half with ten degrees of the center field is gone. His family physician examined him the day following the poisoning and found the patellar reflexes absent. This reflex returned in the course of a few months, and finally became normal. The author thinks the reflexes should be more carefully looked into in these cases. When wood alcohol is burned formaldehyd is generated and has been known to cause amblyopia of a transient form.

Louis Stricker (*The Lancet-Clinic,* May 2, 1908) has recorded two cases of blindness from the inhalation of wood alcohol. Casey Wood and Frank Buller reported 153 cases of blindness and 122 cases of death from drinking wood alcohol. They also reported 3 cases of

blindness from rubbing wood alcohol on the body. A recent examination of toilet articles shows a long list of hair tonics, in which wood alcohol was used. Stricker, in tobacco and alcohol amblyopia, contrary to the findings of Uhthoff, found a decided narrowing of the color fields or total loss of color sense. Mechanical interference with the entrance or exit of blood from the eye, or arteriosclerosis following alcoholism, excessive use of tobacco or lead poisoning, may interfere with the nutrition of the retina, and explain the contraction of the color fields. In most cases, ophthalmoscopically, the picture is negative, occasionally there is a slight hyperemia of the temporal side of the disc or rarely pronounced optic neuritis with flaming hemorrhages in the retina. He believes that "The uncomplicated toxic amblyopias ought to be considered as retinal diseases." After discussing in detail the action of poisons on the nerve elements he says: "As a general proposition, one might say intense poisons produce sudden death of the ganglion cells, atrophy and death of the axis cylinders, and there is no restitution. Chronic poisoning first induces death of the axis cylinders; here prompt interference will arrest the process, and in all probability lead to a subsequent regeneration of the axis cylinders; but where the poison has acted for a long time the ganglion cells die, after which there can be no possible restitution of the axis cylinders." Stricker also emphasizes the physicochemical side of this question, and directs attention to the experimental study of Reid Hunt. He believes that methyl alcohol acts especially on the most highly differentiated nerve structures. From experiments of de Schweinitz and others, it is believed that the methyl alcohol is changed into an aldehyd, then into formaldehyd, which is rapidly changed into formic acid within the body. It is shown by Hunt that the physiologic process of metabolism in the cell of a moderate drinker is changed; that instead of inhibiting oxidation, alcohol increases this power of oxidation, so that substances, which in the case of an abstainer would remain harmless, in the alcoholic are rapidly oxidized and may produce substances which act as a poison to the cells. This may explain these cases of suddenly developed amblyopias in individuals who have practically been moderate drinkers all their lives, and in whom no recent excess can be called upon to explain this sudden attack. "Is it not possible that food products which undergo decomposition (ptomains and leucomains) in the intestinal tract, or even products absorbed, may become toxic in an alcoholic owing to the increased power of cells to split up the molecule, and thus produce substances which produce blindness and death?"

Stricker was probably the first to publish reports of cases of death as well as blindness from inhalation of wood alcohol vapor. Within the period of its employment in America several of these cases (almost invariably among beer-vat varnishers) have occurred, thus emphasizing the fact that the most virulent forms of poisoning by inhalation are found when the fumes are associated with rebreathed air.

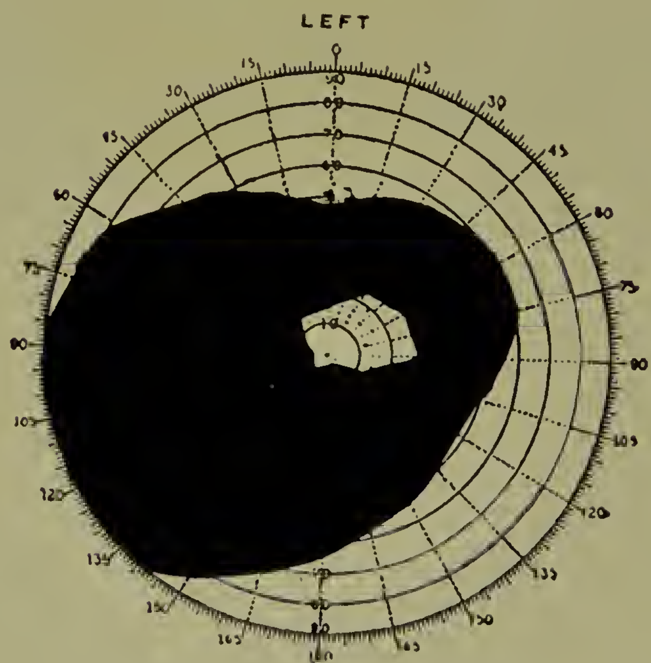
Carhart (*Am. Medicine,* Apr., 1908) also reported a typical example of blindness from methyl alcohol inhalation. C. S., aged 23, a painter by trade, came with a history of being blind in both eyes for 24 hours. He had been working the past 3 weeks in shellaeing the interior of beer vats. For 3 days previous he had had attacks of nausea and vomiting. The vessels of both fundi were markedly engorged, both optic discs obscured by a swelling of their substances, greater above and below than laterally, the right eye being the worst. After free diaphoresis and catharsis were produced, iodid of potash and strychnin were used in increasing doses. In the left eye vision increased to 3 cc, in the right to perception of shadows, the appearance in each eye being that of partial optie atrophy. The engorgement and swelling of the discs gradually disappeared. The close confinement of the air in the vats was the apparent cause. The picture was such as may be caused by taking wood alcohol in bulk, but this occurred only from the inhalation of the fumes.

Harnack (*Deutsch. Med. Wochenschr.*, p. 358, 1912) considers the subject of acute blindness from methyl alcohol. He divides drug amblyopias into two classes: First are those which produce blindness by an acute inflammatory degenerative process attacking the nervous elements of the eye. In this group are placed methyl alcohol, nitrous acid and atoxyl. The second class produce a violent spasm of the retinal vessels, which has the same result as an embolus of the central artery. Into this group fall quinin, filix mas and cocain.

Ten cases of methyl alcohol poisoning are reported by E. von Grosz (*Prac. Med. Series; Eye,* p. 111, 1912). The majority of the patients had taken, in tea, about one to two spoonfuls of rum which was adulterated with methyl alcohol. Blindness set in within a few hours or days, and atrophy of the optic nerve in a few weeks. At the same time 70 deaths from poisoning with methyl alcohol were observed throughout Hungary. The medicamentous use of methyl alcohol must be avoided, especially as a means of solution, as originally recommended for Ehrlich's salvarsan. The writer thinks that the poison affects the ganglion cells of the retina and that the atrophy is ascending.

Mendel reported the ophthalmoscopic findings in the cases of accidental methyl alcohol poisoning in a Berlin Municipal institution. Of

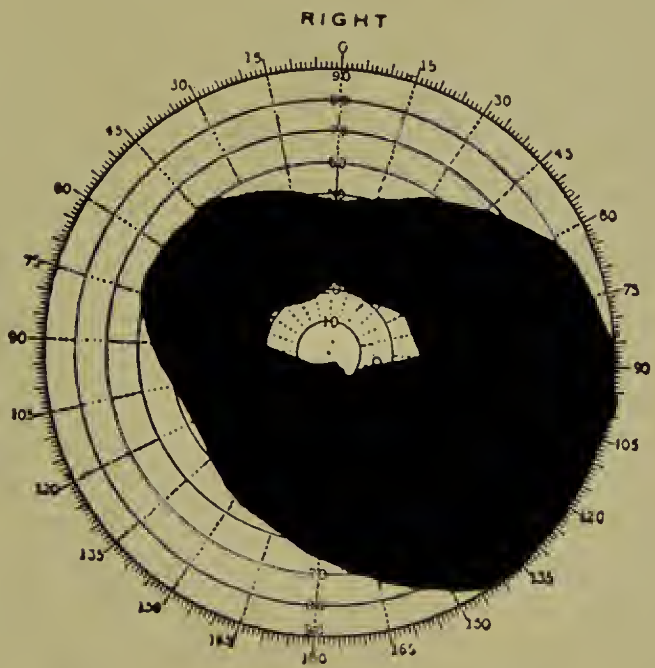
Methyl Alcohol Blindness. Field of Vision. (Ziegler.)



Wood Alcohol Amaurosis.
Field of Vision. (Ziegler.)

130 transferred to the hospital fifty-eight died. In those who died, blindness seemed to have come on an hour or two before death. The fundus showed blocked vessels and in a few cases neuritis and choked

disc. In four of the cases which recovered one eye was entirely blind. In the others vision was reduced to finger counting. Fields could not be taken. Color perception was gone. The pupils reacted to light except in the patients totally blind. The papillæ were pale or white. In the worst cases the atrophic condition was noted as early as the third day. Treatment consisted in the administration of potassium iodid, sudorifics, leeching and Bier's hyperemia. Pick and Bielchowsky (*Wien. Klin. Rundschau*, May 26, 1912) reported their findings in three of the above cases. Two of the three were blind before death. The findings agree throughout with those of Buller and Casey



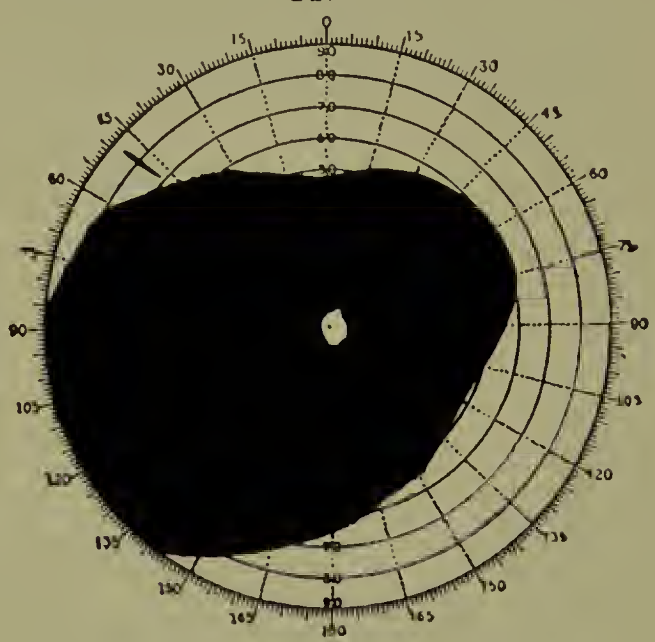
Wood Alcohol Blindness. (Ziegler.)
Field of Vision.

Wood, and also with those of animal experimentation. While there was hyperemia present the lesions could not be considered inflammatory. They occupied the ganglion cells of the optic ganglia, the entire retina and optic nerve. The lesions in the fibers of the optic nerve were primary and coincident, and not secondary to those in the ganglion cells. The affection is considered to be an acute primary degeneration of toxic causation. Tchemolosoff pointed out that methyl alcohol poisoning may be chronic, causing blindness, with little gastric disturbance but with symptoms of nervous degeneration.

Holloway's case of methyl alcohol blindness occurred in a man 58 years of age, who was an habitual and excessive user of ethyl alco-

hol and of tobacco. It had resulted from the ingestion of one pint of this agent. One year later V. = 1/22 eccentrically in R. E. and 6/12 in L. E. The right optic papilla was yellowish-white with an outward shelving cup and a circumvascular inflammation of the vessels in the vicinity of the papilla. The left optic papilla was gray in color. The author remarks that, although the ophthalmoscopic findings do not correspond with Friedenberg's observations, he believes that this might be accounted for by the previous habits of the patient.

In the case seen by Benoit, in a man 20 years of age, the ocular symptoms were absolute blindness, maximum and fixed dilatation of



Wood Alcohol Blindness. (Ziegler.)

the pupils, papilledema, arteries exsanguinated and veins full and tortuous.

Ziegler's (*Ophthalmology,* July, 1911) patient was a woman 49 years of age. About two weeks before, after indulgence in alcoholic beverages, binocular blindness resulted, and had continued despite mixed treatment and strychnin. She was placed upon thyroid extract and negative galvanism. The discs at this time were blanched and atrophic and the vessels attenuated. At the end of a month there was great increase in the vascularity of the nerve head, and l. p. was present in R. E. From this time on, gradual improvement resulted and finally reached 20/50 R. E. and 20/100 L. E., with a superior nasal quadrant field in L. E. and a superior hemianopic field in R. E. He thinks that the specific value of negative galvanism was amply demonstrated by the increased hyperemia of the nerve head,

by its stimulating effect on the nerve fibers themselves and by the consequent improvement in vision.

H. H. Tyson (*Archives of Ophthalm.*, p. 459, 1912) recorded a case where the amblyopia was caused by inhalation arising from shellacing the interior of beer vats. One week after the exposure V. = 1/200 eccentrically. There was optic neuritis with veins and arteries too dark, the former being distended. The retina was edematous. The pupils were widely and fixedly dilated. There was absolute central scotoma extending 30° in all directions from fixation. The form field was contracted 10°. In two weeks' time V. = 20/30 and the scotoma had lifted. Later there were small scotomata scattered throughout, and the field for form became greatly contracted indicating a termination in a tubular field. The notes of two other cases in which the toxemia in pencil-varnishers resulted from inhalation are given. He concludes that methyl alcohol is a subtle poison and should be recognized as such by law; that it may be inhaled in sufficient quantities during the hours of labor to produce amblyopia, blindness or even death; that where methyl alcohol is used in the trades and arts notice of its toxicity should be posted about the premises and an abundance of ventilation should be obligatory.

Casey Wood (1912) reviewed the more recent literature of wood alcohol poisoning. He shows that the danger of poisonous imitations of grain alcohol is still a real one. Out of ten purchases of "Columbian Spirits" made at drug stores in Chicago four placed no "caution" or "poison" label on the bottle. Inasmuch as "denatured alcohol" is generally lower in price than "Columbian Spirits" he finds no excuse, except ignorance, to justify the use of the latter, and he thinks the dissemination of this knowledge would aid in the efficiency of the campaign against its use.

Tchistiakow (*Oph. Year-Book*, p. 237, 1913) reported two cases of methyl alcohol blindness. He concludes that the danger of intoxication with methyl alcohol, with blindness, is very great in Russia because there it is employed not only to adulterate *l'eau de vie*, but in the treatment of diseases by patients themselves. He says that to detect the action of this agent upon man it is necessary to use the ophthalmoscope early, and in cases of death to examine the nerve and retina histologically.

Woods (*Journ. Am. Med. Assocn.*, June 7, 1913) added two cases of methyl alcohol blindness to the growing literature of this subject. One was from the external, the other from the internal use of the poison. In the first case, the patient, a man aged 42 years, had been applying "spirits" (used in a candy varnish) as a daily application

to the calves of the legs and hips, for the relief of muscular pains. Toxic symptoms with failing vision appeared after two months' time and rapidly led to blindness. The pupils were dilated and later both optic nerves became atrophic. Blindness was permanent. The second case was of a young man. Loss of vision followed the drinking of supposed whisky containing wood alcohol. At first the blindness was complete, but later vision in the left eye rose to finger counting, and in the right eye to 1/10. As in Woods' experience the ultimate result is seldom better than the poorest vision observed at any given time he expects the end-result in this case to be blindness. Woods wishes to impress the fact that commercial greed is again threatening the community with this insidious poison, and that it is the duty of the profession to combat this tendency in every way possible.

In a case reported by Onishi, a seaman lost the sight of both eyes, attended by an irregular central, partly ring-shaped, scotoma, after a carouse with brantwein (awaniori). Analysis of the drink showed no ethyl alcohol present. Cure resulted in three weeks' time, an unusual result in methyl alcohol intoxication.

Kasas (*Oph. Year-Book*, p. 238, 1913) explains the clinical picture of methyl-alcohol poisoning by the occurrence of hemorrhage in the sheath of the optic nerve and in the choroid, and circulatory disturbance in neighboring parts. The contraction of the vessels of the septa produces an anemia with diminution of nutrition and degeneration of the nerve. Acidity of the blood and deoxidation of the tissues produces an edema and degeneration of the optic nerve and retina. With the lapse of time the edema diminishes, the collateral circulation is established and the vision improves. But the progress of the process in the optic nerve provokes anew the deterioration of the vision which increases with the atrophy of the nerve.

S. S. Quittner (*Cleveland Med. Jour.*, Nov., 1914) reported unusual symptoms in one of these unfortunate cases. The poisoning occurred in a male patient, 61 years of age. He denied ever having syphilis; had gonorrhea twice; was a heavy drinker for years, but in the past two years states he drank practically very little—in fact, has not been intoxicated during this period.

On July 4, 1914, he went to a paint shop for a pint of wood alcohol. He and another friend then imbibed its inviting contents, his friend consuming but very little (a small glass, as he states), and he draining the rest. The alcohol was taken diluted with water. The patient then stated that after taking but very little (although during the course of the day he consumed the remainder of the pint) he "went

out of his head" and remained that way for three days. At no time, he stated, was he wildly maniacal or had to be strapped down. On July 8—four days later—he suddenly went blind and saw absolutely nothing (not even daylight). For a period of two weeks he remained this way and then the sight gradually returned so that he was able to go about. During this period he went to no physician about this important event and it was not until September 9 that he considered it a matter worth while.

The vision at his first visit was: O. D.=fingers at two feet; O. S.= fingers at one foot. The eye-grounds showed a picture of optic atrophy fairly well advanced, the nerve head paler to a marked degree, and some of the vessels contracted, especially those of the disk.

The perimeter readings showed a contracted field in a regular manner of about half the normal, the contraction being greater on the temporal side. Both eyes approximately showed a reading on the temporal side from 35-40 degrees—below about 50 degrees; above—30-35 degrees, and on the nasal side 35-40 degrees.

The patient failed to recognize red or green in any quantity, recognized blue when a large piece of yarn was presented, but failed to recognize it in a small amount.

He stated that he saw best toward evening. He always wore blue glasses, appreciating himself the benefit of reducing the dazzling of daylight.

The patient was placed on 1/30 grain of strychnin sulphate three times a day, and later the dose was increased to 1/15 grain twice a day. On a later examination he showed an improvement in sight, the right eye recognizing fingers at from 5 to 6 feet and the left eye at from 1½ to 2 feet.

The interesting features in this case are the sudden and acute onset of the trouble, with complete blindness, and the early picture of optic atrophy. Ordinarily one would not expect a complete blindness, or (if the pathology of the condition is accepted of a neuritis in the retrobulbar region) a picture so early of atrophy with the perimeter finding of a contracted field. Ordinarily the limits of the field remain normal, with a central scotoma due to the maculo-papular bundle being first involved. Did the original lesion consist of acute poisoning of the retinal filaments of the ganglion cells, with a subsequent ascending degeneration of the fibers, or was it a retrobulbar neuritis with a descending degeneration? As for the first supposition, it seems the sudden and complete cessation of sight would speak in its favor, for it showed a profound toxemia in these elements. Such an argument is offered in like cases when due to poisoning with quinin. As

for the second supposition, the early picture of advanced atrophy of the nerve-head would speak in its favor, for there may have been some papillitis (due to an extreme swelling in the retrobulbar region of the nerve), and at the time of the first examination had subsided and thus explained this early picture.

Grignolo (*Klin. Monatsbl. f. Augen.*, Feb., 1913) believes that intoxications by toxipeptides (products of disintegration of albumen), e. g., by pepton, the anaphylactic shock, cholera, intoxication by meat, botulism, may occur with very acute symptoms and be confounded with intoxications of other kinds, e. g., by methyl alcohol. Segalo showed that both groups of intoxications can be sharply distinguished by the biochemical conditions of the serum. The writer examined the aqueous of dogs intoxicated by methyl alcohol and pepton (Witte), and found that, while in intoxication by pepton the osmotic pressure and the concentration of the ions of hydrogen are not changed, the osmotic pressure in intoxication by methyl alcohol is extraordinarily increased. It shows that the active substances in pepton intoxication are not diffusible to the eye, whereas those of intoxication by methyl alcohol are very diffusible. This is probably due to a certain selective activity of the epithelia of the ciliary body.

J. A. Campbell (*Journ. Ophth., Otol. and Laryngol.*, Sept., 1915) reported a case in a woman of sixty, with a history of poor vision in the left eye which became much worse about two years previous to examination following a splash of wood alcohol in the left eye while bathing a lady's chest with this fluid. The alcohol rubs were continued for about two weeks. It was from this time that her eyes began to fail. When seen by the author the vision of left was nil and the right reduced to xv/20 with slight contraction of field. The ophthalmoscope showed a gray atrophy apparently equal in each disc. In the absence of any other physical cause the author assumes that the alcohol was responsible.

Birch-Hirschfeld (*Med. Klin.*, Feb. 27, 1916; abstract *Medical Review*, Aug., 1916) has reported two cases of methyl alcohol amblyopia.

The first case occurred in an orderly who drank a small quantity of spirits in a Polish public-house. Headache, vomiting, and diarrhea followed, and next day he was so blind that he had to be led. While the headache persisted, vision slowly improved. His eyes were never painful. Three and a half months later there was moderate dilation of both pupils, and the reaction to light was diminished. After correction of errors of refraction, vision on the right side was 5/10, and on the left side only 5/50. On both sides there was a small central scotoma, which was relative on the right side and absolute on

the left. The optic disc was very pale and slightly blurred. The central scotoma remained unchanged on both sides for several months, but the vision of the left eye improved to 6/18. Eight months after the onset he was discharged fit for active service.

A lance-corporal shared, with four other soldiers, a breaker of spirits obtained from a chemist's shop. He resumed his march without difficulty, but in the evening he suffered from headache and slight nausea. When he awoke next morning he saw things as in a dense mist, and he felt very ill. He lost consciousness, and when he recovered on the third day he was quite blind. His four companions died the day after they had drunk the spirits, which caused intestinal disturbances, convulsions, and heart failure. Whether they developed ocular symptoms or not, could not be ascertained. A month after he had drunk the spirits, the patient suffered from an attack of heart failure, which rapidly improved when camphor was injected. A fortnight later both pupils were widely dilated; the left did not react to light, and the reaction of the right was much diminished. The movements of the eyes were free, and there was no nystagmus. Both optic discs were pale, and their outlines somewhat blurred. The retinal arteries were constricted, while the veins were slightly dilated. The maculæ showed no changes. With the right eye he could count fingers at 1.5 metres, and with the left eye at 1 meter. The right eye showed an absolute central scotoma. No improvement followed treatment with iodin, and three months after taking the alcohol, he was totally unfit for military service.

Continuing, the writer says that it has been estimated that 8 grammes of methyl alcohol may be toxic and 30 grammes fatal. But it is more correct to say that smaller doses of the undiluted alcohol may cause ocular disturbances in some cases, while in others a dose of more than 50 grammes may be innocuous. How great the difference of susceptibility may be is shown by Foster: 8 persons took equal shares of a mixture containing methyl alcohol and other spirits. One died comatose twenty-four hours later; another became completely blind and soon died; while the remaining 6 suffered only from headache and vomiting, but no ocular disturbances.

In most cases there is an interval of several hours, and sometimes even of more than a day, before the first symptoms are noticed. This is the case even when the toxic symptoms terminate fatally. The symptoms are nearly always referred to the digestive tract, and include nausea, headache, giddiness, and vomiting. In severe cases delirium, convulsions, and loss of consciousness set in. As a rule, the ocular symptoms develop before the severe general symptoms mask the pa-

tient's blindness. The ophthalmoscopic demonstration of optic neuritis is of great diagnostic importance, as practically all the other symptoms due to methyl alcohol poisoning are common to other acute conditions. When severe disturbances of vision suddenly develop, and a central, absolute scotoma, with limitation of the peripheral field of vision, is found associated with optic neuritis and signs of gastro-intestinal poisoning, methyl alcohol should be suspected.

Unfortunately, an early diagnosis does not benefit the patient much, for the alcohol is so quickly absorbed that irrigation of the stomach is practically valueless, unless undertaken at once. In one case castor oil, acting as an emetic, is said to have been beneficial. Pilocarpin, inhalation of oxygen, diaphoresis, digitalis and camphor, and rectal injections of hot coffee or saline solution may diminish the general collapse, but can scarcely be expected to mitigate the ocular symptoms. The common view that potassium iodide and strychnin check the development of secondary atrophy is unjustified, as well as the belief in galvanism with which Zeigler claims to have effected improvement in one case. In most cases the fate of the patient's eyes is sealed before treatment. This form of poisoning should be prevented by legislation. The frequency of methyl alcohol poisoning in different countries depends on laxity in prohibiting its improper sale.

Uhthoff (*Klin. Monatsbl. f. Augenheilk.*, Jan., 1915; *Ophthalmoscope*, p. 148, 1916) has also described two cases of methyl alcohol poisoning with visual symptoms. They belonged to a group of two hundred workmen, who, among them, consumed about 40 litres of the alcohol from a cask which they "found" at a railway station. Fifty of them suffered from severe general symptoms, and of these, twelve died. It is not known whether those who died suffered from visual disturbances or not. Of the thirty-eight who lived, two had very serious disturbance of vision, six had slighter visual disturbance, with a relatively small central color scotoma, while almost all the others had transient subjective visual symptoms with no visible ophthalmoscopic changes. In one case, with great loss of vision, there was pain accompanying movements of the eyes. No instance of true muscular paralysis occurred, but in one case there was slight limitation of the field of fixation towards the right side, and in five there were nystagmoid movements in lateral positions of the eyes.

Case 1.—This man drank two glasses of methyl alcohol, "neat," and three days later, began to suffer from giddiness, vomiting, abdominal pains, and sweating. At the same time there was dimness of vision, rapidly increasing to total blindness in twelve hours. The general disturbance passed off, leaving the blindness. Pupils

were medium, and gave no light reactions. Accommodation was paralyzed. There was slight blurring and pallor of the discs. Absolute blindness persisted for eleven days, after which there was gradual improvement, until, sixteen days later, V.R. was "fingers at 0.5 metre" and V.L. "fingers at 0.75 metre." The vision was eccentric. The discs remained atrophic and sharply defined, and the vessels narrow.

Case 2.—The patient drank about 40 cc. Next day there was dizziness, fever, abdominal pain, headache, tiredness, fluttering before the eyes, etc. Dimness of vision came on and progressed, until in five days there was almost total blindness. Eight days later, he could count fingers eccentrically. The discs were blurred. After four weeks, V.R. was 6/60, V.L. 6/24, and in another week V.R. 6/8 and V.L. 6/6. The field was filling out, but a relative central scotoma remained, and there was pallor of the temporal half of the disc.

G. L. Strader (*Annals of Ophthalm.*, p. 632, July, 1916) has recorded the case of a man, æt. 49, who by mistake took two drinks of wood alcohol. He drank about two ounces at one o'clock in the afternoon, and three or four hours later took another drink of about the same amount. Next day he felt exceedingly nervous and called his physician. On the following day he noticed that his vision was rapidly failing; and awoke the next morning totally blind. No headache, and no gastro-intestinal symptoms at any time. Patient had been a hard drinker for a great many years. Two and a half years before he took the Gatlin cure, after which did not drink for two years. Estimates that he drank as much as a quart of whiskey a week during the last half of 1915. Has smoked eight or ten heavy cigars a day, for years.

November 26th began to distinguish light from darkness. From that date until December 10th, when first seen, there was slow improvement.

Right eye vision, fingers at twelve inches. December 10th, left eye vision, fingers at twenty-four inches. Pupils moderately dilated and very sluggish in reaction. Absolute color scotoma. Slight retinal congestion, otherwise fundus of each eye normal. Absolute central scotoma for form. Blood pressure one hundred and sixty. Patient put in hospital. Alcohol and tobacco interdicted. Strychnin nitrat hypodermatically in increasing doses. High frequency current five minutes daily. Gradual improvement.

December 18th, vision of right eye, fingers at twenty-four inches; left eye, fingers at ten feet. Went home to have treatment continued by family physician. Was getting one-tenth grain strychnin three times a day. Improvement in vision continued until March 1st, at

which time vision was reported as being: right eye, fingers, ten feet; left eye, 20/200. Since March 1st vision has been failing, and on March 17th equaled fingers at one foot for the right eye, and ten feet for the left eye.

There was marked light irritation. Nerveheads were pale, and there was considerable headache.

John M. Robinson (*Journ. Am. Med. Assocn.*, Jan. 19, 1918) has furnished a case of wood alcohol blindness in which the question arose of possible anilin (colorite) poisoning. The patient was a Greek of good physique, aged 29. He came June 1, 1917, complaining of smoky vision, and that the sight of the left eye had been failing for six weeks. Vision of the right eye was 20/30 and J.2; the color fields were much contracted; the field for white was moderately reduced on the nasal side, and greatly contracted on the temporal side. No definite scotoma could be located. The optic disk showed possibly a slight pallor. Vision of the left eye was reduced to fingers at 1 foot, except in the upper temporal quadrant, where fingers could be counted at 12 feet. The disk on this side was distinctly pink—a capillary congestion. Neither at this time nor later was there increased tension of either eye, or changes in the media or fundi beyond the disks. The vessels remained of normal caliber, with no swelling nor cupping of the nerve heads. The pupils were equal, and noticeably large, the dilation being marked in reduced light; reaction to accommodation and light was equally sluggish. Twelve days later the vision of the right eye had fallen to 20/70, at which point it remained for about a fortnight, and then sank with the left, so that by September 15 the bare detection of finger movements was the best that either eye could do. Both optic disks in the meantime had become very white.

The family history was negative. The father and mother and nine brothers and sisters were all living and in good health. There had been no visual trouble among the grandparents, as far as known. The personal history was clear up to April 1; no injury, and no illness other than the usual diseases of childhood. Syphilis was denied, and evidences of it were lacking. The patient's wife was well, in her first pregnancy, and since has been delivered at term of a healthy child. The Noguchi test was negative. There was no ataxia. The patellar and other reflexes were normal. There were no signs of tabes or paresis. The teeth, tonsils, nasal accessory sinuses, gastro-intestinal and renal functions and the pituitary and thyroid glands were all given consideration.

The man had worked as a railway warehouseman up to March 1, at which date he obtained employment in a shoe-shining and hat-cleaning

shop connected with a cigar stand. Here he worked for two or three hours each day dyeing hats with a commercial product called "Colorite"—a black liquid dye with a rather faint yet distinct odor of wood alcohol. The place was fairly well ventilated; there was also a door which was very frequently opened on the street. The temperature was about 70 F. His hands were spattered and stained black "about a quarter of the time." After five or six weeks of this he first began to note that objects looked smoky, while coincidently he became easily tired, perspired freely, and suffered slightly from nausea and a somewhat vague "stomach trouble." There was slight headache and dizziness, which, however, eventually disappeared. These symptoms were more or less pronounced when he came under observation after six weeks. When last seen he was once more in good health, but totally blind. This picture is, Robinson very properly held, fairly typical of wood alcohol poisoning of the slow type. To make it a more perfect case, the findings should have included a scotoma, and "contracted retinal vessels," perhaps.

An original bottle of "Colorite," of which the man had used a dozen or more, was sent to the Bureau of Labor Statistics, Department of Labor. An analysis made at the Hygienic Laboratory disclosed 4 per cent. of wood alcohol, the coloring matter being reported as one of the indulin group, negrosin. Though anilin black, as well as other of the anilin dyes, may sometimes be classed as poisons, and have been known to exert deleterious action on the cornea and conjunctiva, no instance of nerve atrophy has been reported as following the use of any of the idulins. The wife and fellow workers stated that he was an abstainer from alcoholic drinks.

Gettler and St. George (*Journ. Am. Med. Assocn.*, Jan. 19, 1918) recorded six cases of wood alcohol poisoning and predicted what has since been abundantly verified, viz: that the prohibition by our government of the manufacture of distilled liquors will unquestionably lead to much "moonshining," adulteration and dilutions of liquors offered to the public. "That such is the case, even at this early period of the war (1918), is quite evident from the recent poisoning in one city of over thirty persons, six of whom died, with a whisky sold in one of the poorer sections of the city that on analysis proved to contain a considerable amount of wood (methyl) alcohol." Believing that similar cases will occur and with increasing frequency, despite the vigilance of our revenue and state officers, the authors warned physicians, coroners and health officers, in order that they may be on their guard in similar cases, as prompt and efficient therapeutic

measures must be instituted to hold any hope for recovery of the patient, and, furthermore, to detect any violations of the food laws.

They believe that the introduction into beverages of the dangerous poison, wood alcohol, is nearly always due to ignorance on the part of the blender. In spite of the voluminous literature on the subject physicians and nearly all of the lay public are unacquainted with the chemical and physiologic differences between the relatively innocuous ethyl or grain alcohol and the dangerous methyl or wood alcohol when applied to the body or introduced into it. The refined wood alcohol tastes like ethyl alcohol; hence the adulterator buys the latter, ignorant that severe poisoning, blindness and often death lurk within it.

Similar but meager histories were obtained in all six cases, and the writers were unable to determine the quantities of the poison taken. One patient died in his own home. All had taken whisky a short time previously, and all had complained of violent abdominal pains, incessant vomiting and extreme weakness. Three complained of blindness.

Supplementing the information just given, it may be stated that a series of experiments conducted by Tyson and Schoenberg led these authors to conclude that the effect of methyl alcohol on the eye is due to its hematotoxic qualities. They consider that the first change produced is a toxic edema of the tissues, which, with the increased viscosity of the blood, interferes with its free circulation. The tissues having been deprived of their nutrition and oxygen, degeneration of ganglion cells and nerve fibers ensues. In the animals used by these writers, a hypotension of five millimeters of mercury or less indicated the certainty of death within twenty-four hours, while with the tension over five millimeters the animal lived for a longer period.

At the date of writing (December, 1919 and January, 1920) the newspapers in all parts of the United States are publishing accounts of numerous cases of the usual, typical forms of death and blindness from drinking various sorts of wood alcohol, but mostly from the use of the deodorized variety. Columbian spirits and its imitations still constitute the most dangerous of all the methyl alcohol preparations, and until there is a stringent enforcement of the well-known precautions death and blindness will continue to result from its use as a beverage.

It may be added that a similar condition, with stories of methyl alcohol intoxication as one of its results, existed (1915) in Russia when a ukase placed a ban on vodka drinking.

Allantiasis. See **Botulism**; also p. 210, Vol. I of this *Encyclopedia.*

Almonds, Artificial oil of bitter. See **Dimethyl sulphate.**

Amanita. Consult p. 282, Vol. I of this *Encyclopedia.*

Ammonium persulphate. Ammann (*Corresp. Bl. für Sch. Aerzte*, Dec. 28, 1918) has reported a case of poisoning by this substance. A workman in a dye factory was the patient, who seemed more susceptible to the action of the chemical than the rest of the workers. He had eruptions on his skin and in the left eye corneal vesicles which for a time disappeared to be followed by fresh crops.

Amyl nitrite. Wood (*loco cit.*, p. 16) says that only a temporary disturbance of vision follows the exhibition of this drug—usually when inhaled—consisting of a hyperemia of the ocular vessels lasting only while flushing of the neck and face continues. See **Amyl nitrite,** in this *Encyclopedia.*

Anhalonium lewinii. See p. 478, Vol. I of this *Encyclopedia.*

Anilin. See the matter on p. 3253, Vol. V of this *Encyclopedia.* To this may be added that in Leboir's case the mydriasis was extreme Müller, on the other hand, observed bilateral miosis. There was defective vision, Jaeger XIX, in each eye, (which improved when the patient abandoned his injurious work) in a case reported by MacKinlay.

deSchweinitz points out that Galezowski was inclined to attribute especial toxic influence to fuchsin as well as to aniline. This is not an accurate observation, because we know from the experiments of Cazeneuve and Lépine that fuchsin is free from toxic properties, while safranin, which is much used as a coloring agent, especially in the red wines, is capable of producing very decided poisonous symptoms.

William Lintz (*Journ. Am. Med. Assocn.*, p. 692, Mar. 3, 1917) has reported one of these rare cases and points out that anilin poisoning occurs in one of three ways: (1) by the swallowing of anilin with suicidal intent; (2) by inhalation of anilin fumes, or (3) by absorption of anilin through the skin from the clothes. The symptoms of anilin poisoning are similar to those of nitro-benzene.

The writer gives the following history: white man, aged 20, single, laborer, admitted July 22, 1916, Hospital No. 38491, had been working for one week in an anilin dye factory. In carrying out his work, he inhaled anilin fumes. He felt weak, especially in the lower extremities, and had severe headache. He tried to walk but was unable, lost consciousness, and was brought to the hospital.

The respiration was slow and superficial. The head and scalp showed no signs of injury. The pupils were equal, regular in outline, dilated, and reacted to light and accommodation. The conjunctivæ were dark-blue. The nose was negative. The ears were bluish. The mouth, lips and gums were dark-blue. The tongue was clear, but

decidedly bluish. The throat was congested. The teeth were in poor condition. The neck showed no rigidity, and no glands were palpable. The finger nails were blue. The chest was well formed; expansion was fair and equal; pulmonary breathing was normal. Heart examination revealed the apex in the fifth interspace, 3½ inches from the midsternal line. The right border was at the right sternal edge. The left corresponded to the apex beat. The sounds were of poor muscular quality, and were irregular in rhythm. There was a systolic murmur at the apex which was transmitted toward the axilla. The second pulmonary sound was accentuated. The pulse was irregular and of poor tension. There was no sclerosis. The abdomen was distended. The liver and spleen were not palpable. There was no tenderness or masses. The extremities were negative. The reflexes were normal. There was a severe acne over the chest and back. A pustular acneform rash existed on the anterior aspect of the chest and forehead (anilin rash?). The patient developed restlessness and pulmonary edema, which subsided under venesection.

The patient was admitted to the ward at 11:30 a. m., July 22, 1916. The heart was hyperactive and the pulses were of poor tension. A phlebotomy was done, and 14 ounces of very dark blood were removed. The patient had projectile vomiting consisting of food previously ingested. He voided involuntarily and expelled dark fluids by rectum. He had some facial twitchings. After the venesection, his color slowly improved. The systolic blood pressure was reduced to 100, diastolic, 80. A hypodermoclysis of 1,000 c.c. of sterile water was given. The condition slowly improved.

July 23, the patient felt much improved. The color was good. He felt comfortable.

July 25, the systolic blood pressure was 110, diastolic, 80.

The temperature on admission was 98.6, rose to 100 in six hours, and then dropped to normal the next day and stayed there.

The pulse on admission was 110; it dropped to 72 the next day, and ranged after that between 72 and 92.

The respiration on admission was 30, dropped to 22 the next day, and then ranged between 18 and 24.

The patient voided 97 ounces in the first twelve hours and over 86 ounces each of the two following days. We have no reason to believe that this increase in urine output was due to any diuretic effect of the poison, but believe that the diuresis can be well explained by the large quantities of fluid given to the patient.

The laboratory examination showed:

Urine	7/23/16	7/25/16
Specific gravity	1.015	1.025
Reaction	acid	acid
Albumin	0	0
Sugar	0	0
Microscopic	Neg.	Neg.
Blood 7/22/16		
Red blood cells		4,900,000
Hemoglobin over 100		

The treatment consisted in venesection, Murphy drip, oxygen inhalation, forced fluids, cold pack, the administration of rhubarb and soda, and hypodermoclysis. The patient having recovered completely, he was discharged from the hospital, July 26, 1916.

When inhaled in small quantities for a long period, anilin fumes give rise to symptoms of chronic poisoning, and one must always bear this in mind among dye-workers, when there is no other explanation for the symptoms. In such cases the sweat may be red or violet. From 10 to 25 gm. is the fatal dose of anilin.

Dr. Merzbach informed the writer that in a nearby dye-factory a provocative test had been practised on all applicants for employment, and had been found very useful in eliminating those who were particularly susceptible to anilin-poisoning. The test consists in making a slight abrasion on the skin of the forearm and rubbing in some anilin. In those who are particularly susceptible to this chemical, symptoms of poisoning rapidly ensue. Such a person is denied employment.

It has also been observed that symptoms of anilin poisoning generally appear after meals; particularly after the noonday meal, the patient will begin to vomit. The question arises, Does the gastric juice liberate the anilin from its various combinations or is the anilin simply then introduced by way of mouth from food, hands, utensils, etc.?

Since nitrobenzene poisoning closely simulates anilin poisoning, it is important to bear in mind that in the former instance the breath, vomitus and the excreta of the patient have an odor of bitter almonds.

R. J. Curdy (*Arch. Ophthal.*, XLV p. 243, May, 1916), reported a case of injury to the eye following the entrance into the conjunctival sac of anilin dust from a copying pencil. The case was seen a few hours after injury. Two weeks later the conjunctiva remained swollen and was covered with a sloughing false membrane, and a ragged

necrotic ulcer appeared on the lower lid. During the following three weeks the ulcer increased and involved the conjunctival surface of the lid to the extent of 8 mm. horizontally and from the lid margin to the fornix. The final result was a narrow symblepharon in the nasal half of the lower fornix and cicatricial entropion of the nasal half of the lid. See, also, *Colorite,* in this section.

Antifebrin. Simpson (Knies, *loco cit.,* p. 345) reported under this synonym of *Acetanilid* (q. v.) a case of contracted and motionless pupil in two and a half hours after taking 105 grains of the drug.

Antipyrin. See in this *Encyclopedia,* pp. 521, Vol. I; as well as p. 10760, Vol. XIV. Wicherkiewicz claims that this drug produces an amblyopia similar to that of sodic salicylat. Guttman observed in a debilitated woman, 25 years of age, a complete though evanescent blindness, which came on after a dose of 15 grains.

Apomorphin. According to deSchweinitz (*loco cit.,* p. 226) this drug has occasionally created visual disturbances; for example, Bergmeister and Ludwig (*Centralblatt f. d. ges. Therapie,* 1885, iii. pp. 193-196) found that the drug in 2 per cent. solution produced, after ten minutes, anæsthesia of the cornea and conjunctiva, and at the same time distinct clouding of the corneal epithelium. This solution was instilled into the conjunctival cul-de-sac, and therefore the action was probably due to its irritant qualities.

Argyrosis oculi. Argyria. This caption receives consideration on p. 574, Vol. II of this *Encyclopedia.* See, also, *Silver nitrate* and *Silver-salts* in this section.

Arsacetin. Consult p. 9048, Vol. XII. From a study of cases of blindness after arsacetin, including anatomical investigations, C. H. Sattler (Graefe's *Archiv.* 81, p. 546, 1912) concludes that the injury to the eye from this agent may occur as a sudden failure of vision without central scotoma, the result of genuine optic atrophy; that, anatomically, the first (primary) neuron may be intact while the second neuron may show shrinking and degeneration of individual nuclei; the third neuron showed by far the most disturbance. There was chromatolysis and vacuolization of the ganglion cells and destruction of the nerve fibres with slight glial growth. The medullary sheaths were more affected in the optic nerve than in the tract. The papillomacular bundle was relatively somewhat less affected than the remaining bundles. The toxic agent seems, therefore, to attack the ganglion cells and the nerve fibre layer, and the anterior portion of the optic nerve (the peripheral section of the third neuron), and to spare relatively the papillomacular bundle.

Arsenical amblyopia. This subject is partly discussed on p. 605.

Vol. I of this *Encyclopedia*. Casey Wood (*loco cit.*) has pointed out that makers of paris green, painters, wall paper hangers, as well as those persons who take the drug for medicinal or cosmetic purposes, are liable to suffer visual disturbances apart from the conjunctival hyperemia and eczema of the lids which often result from long continued exposure to its influence. Hutchinson (Sajou's *Annual*, IV, 1890) thinks that vitreous opacities may follow a too-long course of arsenic. It is also asserted that a medicinal course of arsenic has caused retrobulbar neuritis.

However, in the majority of reported cases the description of the amblyopia is of the hyperemia, edema and pigmentation of the external ocular apparatus that in chronic arsenical poisoning or during long continued medication also affect the skin and mucous membranes elsewhere.

The claim of arsenic to a place in Wood's Class I, Div. 1, is, however, supported by the evidence of more than one witness. Liebrecht reports the following case from Schöler's clinic in Berlin: A man, aged 30, examined on account of misty vision of four weeks standing. V., L. = 20/200 Sn. vii; V., R. = fingers at eight feet and Sn. xvi. Pupillary reaction normal. Ophthalmoscope shows temporal pallor of disk. Field normal at periphery, but there is an ill-defined paracental scotoma for green and red. On the right side (near the fixation point), a very small absolute scotoma. Patient drinks no spirits and only a small amount of beer. Formerly smoked four or five cigars daily—for four weeks none. Doubtful luetic history.

During the previous three years and a half the patient had taken arsenic in pill form (dose unknown) for psoriasis fere universalis, the amount having been greatly increased during the past six weeks until within eight days when he was obliged to intermit it owing to the production of vomiting with pains in head and stomach. The outcome of this case is not recorded but the absolute scotoma, in the absence of other causes, would lead us to agree with the reporter in his assertion that the optic nerve lesion present was the result of the chronic arsenical poisoning and was not due to tobacco.

That cases of *arsenical optic nerve* neuritis occur is well proven. Dana (*Brain*, p. 457, 1887) in giving a full account of arsenical paralysis records such an instance in an American, aged 48, who was ordered Fowler's solution in increasing doses until at last he took ½ oz., t. i. d. After a month of treatment he had peripheral motor and sensory paresis as well as optic neuritis, with normal pupillary reflexes. The medicine was discontinued and in five months the patient was better.

In a second case the vision was impaired without optic inflammation.

H. Derby's (*Bost. Med. and Surg. Journ.*, p. 603, 1891) case is of great interest as the trouble was ultimately traced to the arsenical wall paper in the patient's library. A man of regular habits and previous good vision became so blind that V. R. = 1/20; V. L. = 2/10; bilateral optic neuritis with slight hemorrhage near r. o. d. The urine was found to contain arsenic. After removal of the probable cause patient gradually improved. Krehl records a case of medicinal poisoning (Fowler's solution); a man, aged 23, who, formerly healthy, acquired a horizontal nystagmus of slight degree, with flashes before his eyes on gazing steadily at objects.

According to the experience and reports of Osler, peripheral multiple neuritis is occasionally a result of arsenical poisoning, the symptoms of which closely resemble those due to chronic alcoholism. The remarks made regarding the relation of these nerve changes in the case of alcohol probably also apply to the nervous lesions produced by arsenic. Having them in view one may regard the retinitis and its attendant vitreous disease, seen in Hutchinson's case, as an arsenical neuritis of the peripheral variety. Probably, also, the nystagmus observed by Krehl was due to the same cause—a neuritis of the external ocular muscle supply—that Uhthoff assigned to this symptom in his case of alcohol amblyopia.

Aside from Liebrecht's case, Dana and H. Derby have abundantly proved the production of optic neuritis by this poison. The former thus concludes his elaborate researches: "1. A disease resembling tabes may be caused by arsenic taken medicinally or otherwise. 2. The arsenical paralyses are due to a multiple neuritis. 3. Arsenical paralyses, like those of diphtheria, alcohol and lead, are of two types, (a) the ordinary mixed motor and sensory paralyses, and (b) the pseudo-tabetic form." In other words, the optic neuritis due to arsenic is (or may be) part of a multiple neuritis or it may take on the retro-bulbar form or present the usual picture of an optic neuritis.

See, in addition, the various arsenical drugs—*Salvarsan, Atoxyl*, etc, listed in this section.

Arsenobenzol. See **Salvarsan**; as well as the same sub-head in this section.

Arsphenamin. See **Salvarsan**; as well as the same sub-head in this section.

Aryolarsenates. See p. 1130, Vol. II of this *Encyclopedia.*

Atoxyl. This toxic agent has been discussed for its effects upon the eyesight under various headings in this *Encyclopedia*, notably on pp. 608 and 664, Vol. I, as well as on p. 9048, Vol. XII.

Morax (*Oph. Year-Book*, p. 252, 1909) has collected the reported cases of ocular symptoms produced by atoxyl. In these cases the drug was usually employed for the treatment of a chronic skin affection or of trypanosomiasis. The ocular manifestations always assumed the character of an atrophy of the optic nerve, with or without atrophic pallor of the disk. The visual symptoms set in rapidly and attain their height in a few days. There is always a contraction of the visual field, with reduction in the acuity of vision or total suppression of all perception. When the lesions are once produced, they remain stationary, but partial recovery may occasionally occur. The toxic dose is variable, and this uncertainty is the worst feature in the therapeutic use of atoxyl.

Verderame and Hoppe reviewed the cases of blindness due to the administration of atoxyl in syphilis. After citing the cases of Bornemann, Von Krüdener, Lesser and Greeff, and Fehr, they mention a report of Ayres-Kopke, who saw six cases of double optic nerve atrophy and blindness, out of 29 patients treated with atoxyl for sleeping-sickness. The doses varied greatly, and were not particularly large. Darier admits that by accumulation of the remedy unpleasant effects may appear. Koch reports 22 cases of blindness in cases of sleeping-sickness from its use. The reviewers conclude that an indeterminable personal idiosyncrasy exists for the drug, and therefore great caution is necessary in its administration.

Herford reports two cases of blindness from the use of atoxyl; and in a third case there were produced retinal hemorrhages which disappeared rapidly after withdrawal of the drug. The use of atoxyl should be avoided in cases of affection of the optic nerve or eyeball. Doses above 50 centigrammes are dangerous. On account of its cumulative effect, even small doses should not be continued for any great length of time.

H. Von Krüdener's patient took 50 grammes in seven months. The visual trouble was characterized by pallor of the optic disc and a contraction of the visual field, chiefly nasal in the right eye and concentric in the left eye. In several weeks the blindness became permanent and absolute.

The *Ophthalmic Year-Book* for 1912 also reviews a number of cases of *atoxyl amblyopia*.

Costantino's paper is a review of atoxyl as to its chemical composition, its physiologic action, its therapeutic uses and its toxicology. He records a case in which following the administration of 15 cg. daily for three days, and 30 cg. daily for three days and finally to 40 cg., vision became clouded, color perception subnormal, and the

visual field constricted with a paracentral scotoma. The drug was withdrawn and strychnin substituted but no improvement resulted. Mancione reports a case of optic atrophy in a man aged 40 years who was being given atoxyl for a severe syphilitic cachexia. After the fifth injection vision began to fail, and after the fifteenth practical blindness ensued. When seen by Mancione there was optic atrophy, the discs being sharp and white and vessels narrow, with complete blindness. Treatment was without result. In Garcia Del Mazo's patient, following the injection of 21 grams of atoxyl over a period of two months, vision gradually failed and at the end of five months was reduced to light perception. Edema of the lids and retinal hyperasthesia were noted. The nasal field contracted most rapidly. In a case in which 6 cgm. of atoxyl were administered intraspinously, Grignolo saw blindness occur in three hours, and death in less than two days. Experiments with rapidly toxic doses in rabbits showed, besides a retrobulbar neuritis, inflammatory changes in the retina.

From a study of the literature and his own case in which atrophy of the nerves occurred following repeated injections of atoxyl in the treatment of recent syphilitic infection, Kalashnikoff concludes that when there is marked intoxication by atoxyl, the peripheral endings of the optic nerve are first affected, followed by degeneration of the entire nerve, which stands in intimate relation with the constriction of the retinal vessels; that the drug is markedly toxic to the visual apparatus, even in moderate doses, particularly when administered for a long time; great care must be used in its administration, and with the slightest disturbance of the visual field the administration of the drug should be discontinued. This precaution is particularly timely since Metchnikoff has recommended the use of atoxyl as a prophylactic agent.

Igersheimer considers that his experiments support Ehrlich's view, that the toxic substance of atoxylon is a reduction product. and he holds that today there can be no doubt that the derivatives of phenylarsenic acid to which atoxylon, arsenic, etc. belong, have a very considerable affinity for the nervous elements of the eyeball.

Atropin. The oculotoxic effects of this common remedy are pointed out in numerous places in this *Encyclopedia*. See e. g., the various captions on p. 673, Vol. I, including **Atropinism**. See, also, **Belladonna**.

Eberhardt (*Oph. Year-Book*, p. 82, 1909) reported the case of a girl of 12, who had been subjected to homatropin without any toxic effects, in whom he used atropin solution, one grain to two fluid drams, a drop in each eye four times in the course of an hour. There was

full delirium, skin, lips and throat dry. She recovered in about 15 hours, under use of pilocarpin and morphia. Lesshaft reports 3 cases of atropin poisoning from the instillation of solutions of ½ and 1 per cent. In a girl of 8 suffering from strabismus, von Colditz instilled a single drop of 1 per cent. atropin solution. Three hours later she was dizzy, trembling, and out of her head. After twelve hours she vomited, but hallucinations continued nearly twenty hours.

C. W. Burr (*Archives of Ophth.*, March, 1913) has reported a case of atropin poisoning in which the mental symptoms continued for a period of six weeks. The patient, aged 52 years, had been using a standard atropin solution, for iritis, for nine weeks. The day previous to admission to the hospital she had suddenly become excited and hallucinatory, having both visual and auditory hallucinations. The first twenty-four hours, she had to be restrained physically, later, she became quiet mentally, but the hallucinations continued. She had neither convulsions nor coma. The author believes it was a case of pure atropin poisoning, without any other contributing factor.

Belladonna and its alkaloids. See p. 925, Vol. II; also p. 4514, Vol. VI of this *Encyclopedia*. The early observations of Casey Wood (*loco cit.*, p. 52) are as follows:

The ocular symptoms occasioned by cycloplegic derivatives from the solanaceæ order are probably of peripheral origin. The poison acts by paralyzing the ends of the third nerve distributed to the ciliary muscle and sphincter iridis as well as, perhaps, by stimulating the sympathetic dilator fibers.

General as well as local symptoms from the use of other cycloplegic agents are too well known to spend much time upon them.

Kollock, in common with many others, the author included, has observed serious symptoms after the instillation of such a small amount as 1/60 gr. of duboisin.

Ziem as well as de Schweinitz and Hare report cardiac weakness after the local use of homatropin. Harlan has seen the same drug bring on slight attacks of glaucoma, while Cheney witnessed what he terms "hysterical" mydriasis and blindness following the use of the hydrobromate.

Testi saw well marked cycloplegia and mydrasis in a family poisoned by hyoscyamus albus.

Owing to its stimulating action upon the third nerve center, opium, and especially hypodermic injections of morphia in full doses, is the most appropriate and most useful form of treatment in cases of poisoning from the cycloplegic alkaloids. McGowan, in a case of typical intoxication following a teaspoonful of belladonna liniment,

used hypodermic injections of pilocarpin with gratifying results. See, also, *Atropia*.

Benzine. Petrol ether. Knies says that a case of immobile pupil with nystagmus accompanied intoxication by this poison.

Binitrotoluene. Trivalene. According to Arthur S. Hamilton and C. E. Dixon (*Journ. Am. Med. Assocn.*, June 29, 1918) this high explosive is the product of the second step in the nitration of toluene. When received as monotrinitrotoluene it is a heavy dark-cherry colored oil, and in the process of the second nitration it changes to a crystalline substance looking much like brown sugar. As such it has a faint odor of bitter almonds and a bitter, acrid taste.

Like monotrinitrotoluene it is absorbed through the skin and mucous membranes and when so absorbed seems to have a marked transient and perhaps more or less permanent effect on the central nervous system.

In a certain plant, in addition to the patient here reported and those mentioned by him, there were two cases of pronounced mental aberration and one of somnolence. In the mental cases no delusions or hallucinations were manifested, but rather signs of mental dulness. The men were very quiet, with an aimless tendency to seclusion. One locked himself in an outhouse and was found only after one hour's search. He seemed stupid, could not understand or answer questions, and was mildly apprehensive. He would try to hide away, even in a room that offered no concealment, but still was docile and unafraid on contact with men. This condition persisted for about forty-eight hours, with later rapid improvement and complete recovery.

The other patient had, in addition, a marked cyanosis, with weak heart action, staggering gait and fainting. Recovery occurred within a few days.

A portion of the history and symptoms in an unusual case reported by the writers is as follows: The patient is a well-developed and well-nourished man, slightly pale; height 5 feet 6 inches, usual weight 156 pounds, and present weight 148 pounds. In a period of four days of observation his temperature ranged from 97 to 98.2, pulse 55 to 71, but usually about 60, and blood pressure 134 systolic and 81 diastolic. The tonsils were submerged and showed no special signs of inflammation; the teeth were badly worn, and there was a moderate degree of pyorrhea and gingivitis. The glands were not enlarged; the lungs were normal. Except for a moderate thickening of the blood vessels, the circulatory system was negative. Liver and splenic dulness were not altered, and the spleen was not palpable. There was no abdominal tenderness.

All the cranial nerves were normal except as noted below. With the right eye the patient counted fingers at 14 inches and with the left at 10 inches. The visual field was normal to rough tests except that there was some unusual dulling at the central point. The fundus showed a rather well developed atrophy with pale disk and some swelling of the veins and contraction of the arteries. The right pupil was somewhat larger than the left. The left reacted fairly and the right poorly to light, and both only fairly to distance. Both had had "drops" instilled some days previously. A watch was heard in the right ear at 18 inches and in the left at twelve inches. Air conduction was better than bone in both, and the Weber test was negative. There were no subjective sounds at the time of the examination, but the patient stated that at the time he quit work he had "rumbling sounds" in both ears. Vibration sense was lost in the toes but present in the malleoli and upward. Joint sensibility was distinctly impaired in the toes. Neither sense showed any impairment in the fingers. Pain (pin prick) was usually appreciated in the fingers and in the feet and toes, but touch (cotton) was impaired in both. Tendon and muscle pain sense were normal. There was no incontinence of urine or feces, and sexual power was not impaired. Sweating was evident in the hands and feet.

The muscles were of good volume and tone, but the patient insisted that his strength was much impaired and that his legs would often give way under him. In all the tests he gave very fair responses. He complained of stiffness and of an occasional pulling up or jerking of the feet and legs, especially at night, and said that this seemed like an "electric shock." Coordination was good in the upper extremities and impaired in the lower. The patellar and abdominal reflexes were present but diminished. The Achilles, biceps, triceps, supinator, jaw, pharyngeal, palate, plantar, anal, bulbocavernosus and cremasteric reflexes were normal. There was no patellar or ankle clonus. A blood test revealed: hemoglobin, 80 per cent.; red cells, 4,900,000: white cells, 8,000; differential count: polymorphonuclears, 73.5 per cent.; small mononuclears, 19.5 per cent.; large mononuclears, 5.5 per cent.; eosinophils, 0.5 per cent.; other forms, 1 per cent. The cerebrospinal fluid was clear with no undue pressure. The Wassermann, Nonne, and gold tests and cell count were negative. The Wassermann test was also negative in the blood.

Under treatment with laxatives and potassium iodid and sweating, the patient improved after about two months and has shown steady improvement since. In the month of February, 1918, he still com-

plained of tingling and numbness in the toes. His vision was then 20/40 in the right eye and 20/60 in the left eye.

Blunzen. See p. 1239, Vol. II; as well as *Botulism.*

Botulism. Decayed or decomposed food. This important cause of defective vision has been much discussed in these volumes, especially on p. 2200, Vol. III, and on p. 10468, Vol. XIV.

Casey Wood points out that there is a close family resemblance to certain alkaloids, notably atropia, eserin, curare and strychnia, in the action of ptomains upon the eye and general system. As an example of this, muscarin and neurin produce miosis and spasm of accommodation; tyrotoxin paresis of accommodation and mydriasis.

In most of the recorded instances of toxalbumin poisoning, where life was saved, the visual acuity shortly returned; there were no fundus changes and no injury to optic nerve or retina.

Paresis or paralysis of accommodation (bilateral and usually accompanied by widely dilated pupils) is the most common eye symptom of poisoning by decomposed meat.

Partial and transitory visual failure has frequently been noticed and is likely to be, and probably often has been, overlooked or misinterpreted. M. Knies relates a case where two persons who ate of the same fish (which was apparently above suspicion), had as a result a paresis of accommodation that lasted twenty-four hours.

All the extrinsic ocular muscles have been affected, from bilateral and nearly complete ophthalmoplegia externa to paresis of a single muscle. Of these ptosis is the commonest of the oculo-motor pareses and has been noticed by many observers e. g., by Kaatzer, Hirschfeld, Flury, Federschmidt and Pürkhauser.

These symptoms do not, as a rule, show themselves for several days after the poisoning. Goehm cites a case where the paralysis was first noticed nine days after the ingestion of the food.

Groenouw gives the following account of a few cases:

W. G., aged 29, the next day after eating a full meal of raw ham found that his throat was dry, that he could hardly swallow his food (especially dry bread), and that he was unable to read ordinary print. He was slightly myopic, and it was estimated that he had lost through the cycloplegia present 5 D. left, and 6 D. right, of accommodative power. Under treatment the symptoms slowly disappeared.

Two other cases occurred in the same family and presented about the same symptoms. The ocular signs declared themselves in from two to five days and lasted for nine weeks. The remains of the ham were fed to mice whom it killed in twenty-four hours. Parts of the dead mice were fed to other mice who remained perfectly healthy.

from which it was concluded that the poison was a ptomain or ptomains and that death did not result from bacteria, none of which could be detected in the ham or dead mice.

Eichenberg noticed in a case of sausage poisoning, which ended fatally, not only a third nerve paralysis, but a unilateral abducens paresis. Federschmidt saw twenty-two cases of "Wurstgift," the ocular symptoms being in addition to accommodative failure, dilated pupils, cloudy vision, diplopia (three cases), and in one instance paresis of the levator palpabræ superioris.

The differential diagnosis of these cases may not always be easy, especially from diphtheria and poisoning by the mydriatic alkaloids. The presence or absence of paralysis of the extrinsic ocular muscles, the course of the accommodative paresis, as well as the nature of the general symptoms must, of course, be considered. An American practitioner wrote a short article for a well-known medical journal in which he described several cases of atropin poisoning from eating turkey. He explained the symptoms by assuming that the bird in question had, just before his death, fed on belladonna berries or some other plant possessing cycloplegic properties, and that when served at the table his flesh, being impregnated with the poison, had acted like an overdose of belladonna extract. This error was quite pardonable and doubtless many physicians, unaware of the cycloplegic action of tyrotoxin (tyrotoxicon) and other ptomains, have made similar mistakes.

The prognosis is generally good and recovery is usually rapid. When death does not occur and the muscular paralyses persist it is likely that central changes (basilar neuritis or meningitis or nuclear hemorrhages) have been produced by the intoxication. Some of these last cases present symptoms closely resembling typhoid fever (even to changes in Peyer's patches, intestinal ulcerations, etc.), and may easily be mistaken for it.

Grignolo (*Klin. Monatsbl. f. Augenheilk.*, Feb., 1913) believes that intoxications by toxipeptides (products of disintegration of albumen), e. g., by pepton, the anaphylactic shock, cholera, intoxication by meat, botulism, may occur with very acute symptoms and be confounded with intoxications of other kinds, e. g., by methyl alcohol. Segalo showed that both groups of intoxications can be sharply distinguished by the biochemical conditions of the serum. The writer examined the aqueous of dogs intoxicated by methyl alcohol and pepton (Witte), and found that, while in intoxication by pepton the osmotic pressure and the concentration of the ions of hydrogen are not changed, the osmotic pressure in intoxication by methyl alcohol is extraordinarily

increased. It shows that the active substances in pepton intoxication are not diffusible to the eye, whereas those of intoxication by methyl alcohol are very diffusible. This is probably due to a certain selective activity of the epithelia of the ciliary body.

Niels Hoeg (*Hospitalstidende,* 1915, p. 300; abstract in *Ophthalmology,* Apr., 1917) examined a patient who after eating preserves a few days previously, suddenly fell ill with severe headache, vomiting, blurred sight, constipation and dryness of the throat. The sphincter of the iris and the muscle of accommodation in each eye were completely paralyzed. There was dry pharyngitis, dryness of the skin, emaciation and loss of strength. In the course of a few months the symptoms disappeared; first the constipation, then the eye affections, but the sensations of dryness and emaciation lasted for a long time. The affection was ascribed to botulism.

The *Journal of the Am. Med. Assocn.,* Feb. 16, 1918, discusses this subject at length, and as follows: The decline in popularity of the expression "ptomain poisoning" is a happy omen. It represents a transition, gradual though it may be, from a poorly supported hypothesis as to the etiology of a state of disease to more concrete and more readily verified conceptions. As we review the evidence from our present position, gained by the advances of scientific investigation and an unrelentingly critical attitude, the suggestion of a close connection between the products of bacterial decomposition in tissues and the occasional outbreak of gastro-intestinal upsets in man is no longer so compelling. In the first place, the majority of the basic derivatives found in mediums in which bacteria are growing have proved not to be highly poisonous. These "ptomains" are for the most part amins formed from the amino-acids that are yielded by the proteins of disintegrating tissues. As they were among the first of the products of bacterial change in nitrogenous mediums to be recognized and dealt with by the chemist, it is not surprising that attention was centered on them as holding out the prospects of something definite in the explanation of the obscure intoxications following food ingestion. Often their actual existence has been postulated rather than demonstrated. Many an item of food has undoubtedly been unjustly charged in the past with containing unknown or undiscovered products of bacterial spoiling.

Jordan of the University of Chicago pointed out that ptomains are formed in the later stages of protein decomposition. He contends that by the time they are present, food containing ptomains would without much doubt almost invariably be condemned by the senses as nauseating and unfit to eat. But, as Jordan especially suggests, other and

more tenable explanations can now be advanced to explain the genesis of food-poisoning. Those outbreaks that have been most thoroughly investigated, says Jordan, have been found to be due not to the use of spoiled food containing ptomains, but either (1) to the presence of true bacterial toxins comparable to those of the diphtheria and tetanus bacilli and not to be regarded as the simple products of decomposition, or (2) to infection with specific bacteria borne in or on the implicated food article.

It may be objected that a toxin is today scarcely less vague in its significance than were the ptomains of a generation ago. It is true that the chemical nature of the so-called toxins remains to be elucidated. They are currently described as the chief poisonous products of bacteria, and are conceived to be manufactured specifically by synthetic processes. At any rate, emphasis is thus placed on specific micro-organisms rather than on food, per se, as the significant factor in the harmful situation.

It is worthy of emphasis that foods serve in a peculiar way as culture mediums for certain bacteria that produce highly poisonous toxins. Instead of perishing as they do in the air, water or soil, the micro-organisms multiply, so that, to quote Jordan, a very large proportion of the recorded outbreaks of food-borne intoxications have been traced to foods that have been prepared for the table and then allowed to stand before being eaten. Cooking, so far from surely destroying all bacteria, may, in some cases, provide a favorable temperature for their multiplication, if the heat is not made to penetrate all parts of the medium thoroughly. Milk is a well recognized carrier of danger. Less well known is the fact that meat may be the source of infection with the micro-organisms of the paratyphoid-enteritidis group. It is these that so often give rise to acute gastro-intestinal symptoms characteristic of so-called ptomain poisoning.

During the year 1918 there were reported both in France and Great Britain several series of cases of obscure etiology in which extreme ophthalmoplegia, ptosis, and nystagmus were among the most definite and constant symptoms. Morax (*Ann. d'Oculist.*, p. 345, 1918) furnished a series studied under the name *lethargic encephalitis*. He found about one-fourth of the cases fatal. In the ophthalmoplegia the accommodation and iris movements are impaired in exceptional cases; generally only the external muscles suffer. Hall (*Lancet*, April 20, 1918) saw ten cases in a month, and entitled it "an epidemic of toxic ophthalmoplegia." The Lancet promptly labeled it "botulism" poisoning, probably due to the bacillus botulinus.

Seven additional cases were also reported from London, as "toxic

bulbar paralysis, possibly botulism;'' while Buzzard reporting another case called it a ''toxic encephalitis.'' Melland (*Brit. Med. Jour.*, May 18, 1918) reported thirteen cases occurring within six months under the title ''epidemic polioencephalitis.'' In two there was marked optic neuritis, but in some cases the symptoms of ophthalmoplegia were slight or even entirely absent. Seven cases are reported by Kinnier-Wilson (*Lancet,* July 6, 1918) under the title ''epidemic encephalitis,'' a name appropriate to a view of the disease which he supports by two necropsies. The bacillus botulinus has not been recognized; nor has any particular article of food been found to carry the poison. Among the thirty-nine British cases there appear to have been eight deaths.

C. G. Jennings (*Journ. Am. Med. Assocn.*, Jan. 10, 1920) gives an account of seven cases of botulism from eating a jar of ripe olives. The *bacillus botulinus* was isolated in each case; five patients died in from 12 to 72 hours. The third, fourth and sixth nerves were paretic in seven instances. There was ptosis of one or both lids and diplopia, in all the cases affected, but mydriasis was marked in only one. Nystagmus was seen in one instance.

Bromism. Bromoderma. The eruptions due to poisoning by bromine and bromides sometimes affect the lid skin. A well marked case in a child—well illustrated—is reported by John E. Lane (*Journ. Am. Med. Assocn.,* June 9, 1917). The patient entirely recovered. See, also, *Potassium bromide.*

Buttermilk. See *Ptomains;* also p. 1348, Vol. II of this *Encyclopedia.*

Cacodylates. See p. 605, Vol. I of this *Encyclopedia.*

Cannabinon. See p. 1382, Vol. II of this *Encyclopedia.*

Cannabis indica. Cannabis sativa. Consult p. 1382, Vol. II and p. 2199, Vol. III of this *Encyclopedia.*

Casey Wood says of this agent that although according to Ali chronic indulgence in ''haschisch'' produces an amblyopia of the nicotin-alcohol type, the eye symptoms accompanying acute poisoning are by no means constant or characteristic. James Oliver (*British Medical Journal,* May 12, 1883) noticed dimness of vision and weakness of accommodation, the pupil being contracted, or of normal size. On the other hand, Casiccia's case developed mydriasis accompanied by hallucinations of vision, ''lights and sparks of fire before the eyes.'' Susskind also reports dilated pupils, while in Seifert's case the pupils were of medium size and reacted slightly to light. Werner has also reported an instance of cloudy violet vision in a small, nervous woman, developed by ⅔ grm. of the extract taken in nine divided doses. We

may accept all this as evidencing the truth that the symptoms of chronic and acute poisoning produced by many drugs are often widely different.

Iglesias (*Annaes Paul. de Med. e Cir.*, Sept., 1918; abs. *J. A. M. A.*, May 24, 1919) states that cannabis sativa is cultivated in certain regions in the north of Brazil where it is smoked in a special pipe, the smoke passing through water, or in the form of a cigar. He had been experimenting with laboratory animals placed in conditions like those of these human inhalers of the cannabis smoke. The animals showed signs of toxic action, vomiting, paralysis and torpor, but they were transient; the animals had quite recuperated by the end of two hours. Intravenous injections of some of the water through which the smoke had been passed caused no toxic symptoms in the animals. Iglesias describes some special instances of the cannabis smoking vice to illustrate the apparently inevitable mental derangement which its frequent use entails, the hallucinations liable to lead to crime or suicide. The cannabis smokers often form clubs for smoking in common at first, but when they become addicted to the vice they prefer solitude, and gradually fall into the aspect and manners of idiots. The drug is called mostly diamba in Brazil, hashish in the Orient. Iglesias urges prompt government measures to check this vice.

Cantharellus aurantiacus. See p. 1383, Vol. II; also under **Amanita**.

Carbolic acid. See *Phenol*.

Carbon dioxid. Consult p. 1406, Vol. II of this *Encyclopedia*.

Carbon disulphide. This important oculotoxic agent is given a place in several volumes of this *Encyclopedia*. See, for example, p. 1403, Vol. II, and p. 9047, Vol. XII.

In addition, Casey Wood's (*loco cit.*, p. 34-37) account of the blindness from carbon disulphide is here given.

The principal difficulty in setting forth the symptoms of carbon disulphide poisoning resides in the fact that many of the patients were either smokers or drinkers, or both, and it is a question whether the central scotomata in some of the published instances may not have been due to these agents. When, however, vision was good previous to the bisulphide poisoning, we may properly attribute the amblyopia to the latter chemical.

As in quinin amblyopia, there are doubtless many cases of transitory amblyopia and partial poisoning unrecognized and unpublished. Of the cases investigated by the British Ophthalmological Society in 1885, twenty-four in all, many were smokers. As typical examples of the eye symptoms in carbon bisulphide poisoning, the following

abstracted cases may be noted. The first was published by Gunn in 1886; the next two are from Hirschberg's clinic while the fourth was reported by Becker:

Case I. Thomas W., aged 33, worked continually with bisulphide of carbon as stillman in oil works for fourteen years, and was exposed to bisulphide of carbon fumes for the last five or six years. The chloride of sulphur is also employed in the works. His general health has failed for the last year; has suffered from aching in the ankles and arms, and pain in the muscles, particularly after walking; loss of appetite, pain in the temples, "a feeling of having had a blow on the top of the head." On two or three occasions, some months ago, he completely lost power over his lower limbs. About four months ago his sight began to fail. He has been married for ten years; within the last eight or nine months has noticed a failure of sexual power. He is a moderate drinker, his average being not more than two pints of beer daily. He smokes one and one-half ounces of strong tobacco weekly, his first morning pipe often making him feel sick. Present condition: He is nervous, indeed almost hysterical. His gait is normal, and his knee jerks moderate. Pupils wide, act fairly to light. Tn. He can decipher J. xix, each eye. Red and green blindness complete, but detects blue and yellow moderately well. Field of vision for a while good, very slight peripheral contraction. R. O. N. very pale, large vessels of good size. L. O. N. opaque looking, and somewhat pale, large vessels normal.

Case II. Worker in rubber factory, aged 16, came January 18, 1886. Had worked a year with CS_2 and SCl. At Christmas, vomiting, sulphur eructations, headache, restlessness at night, wandering in mind. Then visual disturbances; R = fingers at twelve feet, L = seven feet. Field of vision normal at the periphery, but there is a large absolute central scotoma with a radius of twenty degrees. Colors are seen outside. Normal fundus. On February 11, the scotoma is ring-shaped, small, and paracentral. On February 22, V., R. = fingers at fifteen feet; V., L. = fingers at seven feet.

Case III. A girl, aged 26; worked in a rubber factory, and was exposed from two to three hours daily to the fumes of CS_2 and SCl. V. = 22/100, *u. o.* Central scotoma for colors, white doubtful. The fundus was normal, but both maculæ were stippled and had the peculiar look noticed in the anemic fundi of animals poisoned by naphthalin. Recovery was slow. In six weeks V. = 20/30.

Case IV. Reported by F. Becker: A. G., aged 66, worked in a rubber factory on articles which he was obliged to immerse in a solution of chloride of sulphur in CS_2. First had sweet taste in mouth,

loss of appetite, and cramps in the calves of his legs. Then gradual affection of sight. A moderate smoker and drinker. V. = fingers at three meters. Periphery of field uncontracted, but large central scotomata for red, green, blue, and yellow. Temporal half of papilla very pale. In a month V. = 1/5, but a small scotoma for white remained, and Becker did not think vision would further improve.

The investigations of the committee appointed by the British Ophthalmological Society, to report upon the subject of bisulphide of carbon amblyopia, led them to believe that it is the inhalation of the vapor, and not the contact of the hands with the chemical that produces the poisonous effects. The earliest symptom, and the most constant one, according to Delpech, is severe frontal and temporal pain, as if the head were squeezed in a vise. The workmen attributed this to the smell of the sulphurizing fluid, and in support of this belief is the significant fact that the only patient of Delpech's who had no severe headache was the subject of anosmia. Patient's clothes, breath, skin, and hair have a "rubbery" odor. The stage of exaltation (Delpech) presents the following features: Loquacity, vertigo, and a feeling of drunkenness in going into the outside air. Variable spirits and an irritable temper. His appetite is often increased, and he becomes sexually excited. Vision now suffers, he sees objects as through a mist. Hearing is even more frequently affected. Often there is general hyperesthesia. These symptoms are followed by a stage of depression, when there is anorexia, disturbed sleep, and mental failure. Now there is an anesthesia of the skin, especially of the limbs; cramps, great muscular weakness, impairment of sexual desire, or complete anaphrodisia. Fingers became stiff and numb. Vision is now greatly impaired, fog or mist appearing before the eyes even in broad daylight. Pupils are dilated. The peripheral field is uncontracted, but central negative (and sometimes positive) scotomata are invariably present. Pallor of the disc with indistinctness of its margin often noted.

These symptoms increase in severity as long as the patient is exposed to the poisonous fumes, and finally he loses his memory entirely, and is unable to stand upright.

Of the twenty-four cases reported upon, twenty-two were in men. Their ages varied from 15 to 52, ten being under 25. The prognosis is, so far as concerns sight, very fair if the sufferer can entirely give up his deleterious occupation. Of twenty-four cases, eight recorded very good or perfect vision; seven others improved more or less; in five, there was little or no improvement.

A full report by Gallemaerts of a case of amblyopia from carbon

disulphide, illustrated by charts of the visual fields, with remarks upon the pathology of the disease, may be found in the *Annales d'Oculistique* for 1890.

Chloracetone. E. Ammann (*Correspondenz Bl. für Sch. Aerzte,* Dec. 28, 1918) gives an account of three cases of poisoning from this irritant, gaseous agent. The patients were workmen in a chemical goods factory and the lesions were mostly of the conjunctiva and cornea, especially of the latter. A well-marked edema of the lids, severe conjunctivitis and a "stippled" appearance of this cornea in both eyes. The cornea opposite the interpalpebral space was cloudy and the corneal epithelium in some instances removed. There was considerable pain, relieved by cocain. The symptoms disappeared in from two to three days. Ammann says the process resembled closely a severe sunburn of the cornea, and was, indeed, a kerato-conjunctivitis.

Chloral and its hydrate. See p. 2062, Vol. III; also p. 7134, Vol. IX of this *Encyclopedia.*

Most authors agree with Griffith that after the continued use of chloral, the pupil almost invariably becomes contracted, but later on psychic alterations set in and then the pupillary contraction gives place to dilatation. The miosis, which is the symptom most commonly observed, is associated with loss of the normal pupil-dilatation-reflex from irritation of the sensory nerves in the ocular neighborhood. This contraction of the pupil is the result of paresis of the sympathetic nerves supplied to the iris.

Usually there are no fundus changes, although Berger speaks of a congestion of the papilla, when mydriasis is present, due to congestion of the retinal veins. Ulrich says that in the later stages slight pressure upon the globe is sufficient to force the blood out of the papillary vessels and then the intraocular tension is lessened. There is then an anemia of the retinal vessels. Cheatham has had two cases with photophobia and conjunctival hyperemia, which he ascribes to chloral, having seen them follow a single dose of 15 grains. Visual disturbances, due to organic alterations, are very rare.

Mittendorf had a patient who had been taking 2.5 to 3 grms. of chloral hydrate daily. There were greatly impaired vision and small central scotomata for red and green, while the papillæ were muddy. Chloral stopped and strychnia administered. Improvement began in four days; in three weeks vision was two-thirds with no scotoma. Kirkpatrick Murphy observed in a woman, 58 years of age, who took 150 grains daily, dimness of sight, eyes bloodshot and constantly watering, pupils dilated and temporary amaurosis lasting two days.

Very little is known about treatment. C. J. G. Sinclair Coghill is

an advocate of amyl nitrite, and in a case of complete miosis from chloral used the former remedy with success.

Chloroform. See p. 428, Vol. I of this *Encyclopedia.* Wood's account of this subject says that apart from the condition of the pupil in the various stages of chloroform narcosis there are no ocular symptoms, properly so called, pathognomonic of this intoxicant. Niemann records a case of acute poisoning from drinking chloroform: the man first presented contracted and, later on, dilated pupils.

Schlaeger, Vogel and Budin have made elaborate studies of the pupillary reflexes in persons under the influence of chloroform, investigations that add very little to the everyday experience of the surgeon.

During the period of excitement the pupil is dilated, but as the inhalation proceeds and the medulla and cerebral centers become paralyzed the pupil contracts—a well marked miosis indicating that the anesthesia is complete.

Chocolate. Hocken early laid claim to this drink as a cause of amblyopia, and de Schweinitz (*loco cit.*) points out that Casey Wood (*Medical Record,* p. 843, 1895) has recorded a case of temporary amblyopia from chocolate. The patient, a man aged fifty-four, of gouty habit, was subject to attacks of migraine associated with central scotoma (scotoma scintillans). Eating chocolate in any form invariably precipitated an attack of this kind. Wood thinks this case indicates that chocolate occasionally affects the visual centers.

Chromic acid. A five per cent. solution applied as a remedy for perspiring feet has produced temporary yellow vision.

Chrysarobin. This agent is extremely irritant to the external eye and is known to have caused a violent conjunctivitis as well as keratitis.

Chrysophanic acid. A. Trousseau (*Bull. Soc. Frs. d'Ophtal.,* p. 292, 1886) has recorded a case where alleged eye symptoms followed the application to the skin of a 10 per cent. ointment. The inunction produced an acute hyperemia of the conjunctiva that disappeared in a few hours. This, the writer found, differed entirely from the conjunctivitis caused by the direct application of the ointment to the conjunctiva itself, the latter affection persisting for eight days.

Cimicifuga. Cohosh. Consult p. 2248, Vol. III of this *Encyclopedia.*

Cinchona. Cinchonin. Cinchonidin. See p. 2248, Vol. III of this *Encyclopedia,* also *Quinin* in this section.

Coal gas. An account of ocular disturbances brought about by one or more of the various agents in illuminating gas is furnished by Wood (*loco cit.*, p. 55):

Intoxication from poisonous combustion products, especially from carbon monoxid and carbon dioxid, as well as from hydrocarbons and other compounds in illuminating gas, is occasionally accompanied by ocular symptoms. This is not to be wondered at when one remembers the widespread organic alterations, particularly capillary hemorrhages and fatty metamorphoses found after death in brain, nerves, muscles, kidneys, etc. Where recovery occurs the eye symptoms are usually due to similar changes in various parts of the visual apparatus. The minute hemorrhages, that also occur in phosphorus poisoning, are the results of fatty degeneration of the capillary vessels.

An interesting history is given by Knapp. The patient, exposed to the fumes of an imperfectly covered stove, suffered from loss of consciousness after which he had paralysis of several ocular muscles. In the course of two months there was partial recovery, the paralysis being then confined to the ciliary muscle and sphincter pupillæ.

Illing reports a case of homonymous hemiopia due to cerebral disease, while Emmert more recently records a paresis of the third nerve (left eye only) associated with a partial trigeminus and facial paralysis. Recovery in this case was almost perfect.

Retinal hemorrhages have been observed by Becker and others. In Becker's case there was marked congestion of the retinal veins.

Pure carbon dioxid poisoning presents no constant eye symptoms. A mechanical congestion of the retinal veins, as a part of a general venous stasis partly due to asphyxia, has been noticed in association with fundus hemorrhages. Sometimes the pupil is dilated; sometimes contracted. Ball records a curious fact: while a patient was suffering from the effects of the poisonous inhalation the pupils dilated when light was allowed to fall upon the eyes and they contracted in the dark!

See, also, *Carbon dioxid.*

Cocain. The toxicity of this well known alkaloid and its various salts has often been referred to in these volumes. See, e. g., p. 2307, Vol. IV, as well as p. 2302, Vol. III.

The "drying" effect upon the cornea of the drug is also well known, and the probability of its (rare) precipitation of an attack of glaucoma is recognized.

R. J. Hamilton (*Liverpool Med.-Chir. Journ.,* 1916) has pointed out in the latter instance, that two cases have been published in the *Ophthalmic Review,* one by James Hinshelwood in 1900, and the other by Simeon Snell in 1901.

Hamilton's own case is as follows: W. H. B., aged 61, came to him complaining of headaches and tired eyes on reading. His refrac-

tion was insufficiently corrected for reading. The pupils were active and equal, and responded readily to light. There was no increase of tension. By ophthalmoscopic examination there seemed to be a slight difference in the color of the discs: so five or six drops of a fresh 5 per cent. solution of cocain were instilled into each eye.

After twenty minutes there was a wide dilatation of both pupils, and the difference in color in the two discs was explained by the presence of a slight cupping of the left disc. A general narrowing of the arteries could be made out, with a clearly-defined line of reflection, suggesting arterio-sclerotic changes.

The writer generally used escrin after cocain dilation in elderly people, but did not do so on this occasion.

On further eliciting the patient's history, he said that he suffered from increased blood pressure; his doctor had warned him it was 180, and that he had been obliged to retire from business about three years previously, as excitement and worry produced the most intense throbbing and painful sensations at the top of the head. The pulse also gave evidence of an arterio-sclerotic change, and hypertonus was probably also present. The man was a total abstainer, but was always flushed after meals.

During the evening he was very excited and talked a great deal; at ten o'clock violent pain in the eyes and at the top of the head, with some vomiting, began, and continued all night.

On the following morning there was an acute glaucoma in both eyes: purple-red injection of conjunctivæ and scleral vessels, steamy corneæ, widely dilated pupils, tension +3, and vision reduced to bare perception of light.

Under ether anesthesia an iridectomy was performed that afternoon on both eyes. There was considerable hemorrhage both into the anterior chambers, as well as through the corneal incisions. The result in the right eye was excellent, vision ultimately becoming normal, and small print easily read with his reading glasses. The strangulation in the left eye had done more damage, and the vitreous, three weeks later, was full of "floaters," with vision amounting to finger counting only.

Coffee. Caffein. Strong solutions of caffein and its salts applied to the cornea act as a weak mydriatic and anesthetic. Hutchinson refers to a case of caffein amblyopia, the symptoms of which resemble those of the amblyopia of quinin intoxication.

Casey Wood (*Ophthal. Rec.*, March, 1915) reports a case from notes given to him by the neurologist, Harrison Mettler.

A woman, aged 53, noticed numbness in her toes, ascending to the

knees and then to the hips; then numbness and pain in the arms. Pains in the arms and back, and weakness finally appeared. She also had poor eyesight for four years. Hearing was dull; speech troubled; reflexes were diminished; partial wrist drop. She drank from sixteen to eighteen cups of coffee a day.

Diagnosis: polyneuritis from excessive coffee.

Complete recovery, including restoration of eyesight, followed cessation of coffee-drinking. Unfortunately, there was no exact measurement of vision and fields, and no fundus examination was made.

Colocynth. For a reference to the oculotoxic relations of this drug, see p. 2360, Vol. IV of this *Encyclopedia.*

Colonial spirits. See p. 2361, Vol. IV of this *Encyclopedia;* as well as under *Alcohol, Methyl,* in this section.

Colorite. See *Anilin,* as well as *Alcohol, Methyl* (final third) in this section.

Columbian spirits. This very poisonous and dangerous form of methyl alcohol has been discussed a number of times in this *Encyclopedia.* Consult, for instance, p. 2510, Vol. IV, and p. 3257, Vol. V. See, also, under *Alcohol, Methyl,* in this article.

Coniin, from *Conium maculatum* and other plants, has caused, according to H. Schulz (*Deutsch. Med. Wochenschr.,* p. 255, 1885) lachrymation, burning sensations in the conjunctiva and inability to hold open the lids. de Schweinitz says of both gelsemium and conium that they are drugs which, either in the form of their active principles or as tinctures or fluid extracts, have very decided actions upon the human system, paralyzing peripheral motor nerves, and therefore affecting the iris and ciliary body. They do not, however, produce disturbance of vision in other respects. See, also, p. 2996, Vol. IV of this *Encyclopedia.*

Copper arsenate. See p. 604, Vol. I of this *Encyclopedia;* as well as under *Arsenical amblyopia,* in this section.

Corn, Diseased. See *Pellagra;* also, p. 1353, Vol. II, and p. 9401, Vol. XII of this *Encyclopedia.*

Cosmetics. See p. 3543, Vol. V; also *Face powder;* as well as *Hair dyes,* in this section.

Creolin. The only record of toxic amblyopia from this agent was made by Bitter (*Centralbl. f. Gynecol.,* p. 888, 1890) who described three cases of poisoning accompanied by "black vision."

Croton oil. See p. 3571, Vol. V of this *Encyclopedia.*

Crustaceans as food. See *Botulism,* herein.

Curare. de Schweinitz (*loco cit.*) says that this drug, much used in physiological experiments to paralyze motor nerves, is said to

cause miosis when given internally. Galezowski and Mangin have shown that a collyrium of the drug instilled into rabbits' eyes causes anemia of the papilla by diminishing the calibre of the capillaries.

Cystisin. Cystisus laburnum. These agents, according to Clifford Albutt, have produced mydrasis, with pallor of the optic nerve and small retinal vessels.

Daturism. Consult p. 3750, Vol. V of this *Encyclopedia.*

Decomposed or decayed food. See *Botulism,* herein.

Dichlorethylsulphide. See *Mustard gas,* in this section.

Digitalis. A single example of this rare cause of amblyopia will suffice. The case is recorded by Jeanton. A patient took 90 grms. of tinct. digitalis. Nausea and vomiting followed with mydriasis and cloudy vision. For two days there was also xanthopsia.

Dimethyl sulphate. Consult p. 3972, Vol. V of this *Encyclopedia.*

Dinitrobenzol. Nitrobenzol. See p. 3973, Vol. V of this *Encyclopedia.*

The account of amblyopia from (benzol and) dinitrobenzol is given by de Schweinitz (*loco cit.*, pp. 127-133), as follows:

Dinitrobenzol results from the action of nitric acid on benzol at a high temperature, and is used in making explosives, such as "roburite" and "Sicherheit."

Attention was first called to the effect of these substances on the visual functions by Nieden (*Centralbl. f. prakt. Aukenheilk.*, 1888, XII, p. 194) who found defective vision in one person among twenty-five, who suffered from the toxic influence of the chemical. Ross (*Medical Chronicle*, 1889, X, p. 89) mentions the case of a miner who used roburite, and who "felt blind" when fixing his eyes in a certain position, i. e., on a mirror placed above their level. The imperfect vision was probably due to the nystagmus from which he suffered, and not to the nitrobenzol.

Professor White (*The Practitioner,* 1889, xliii., p. 14, and *Provincial Med. Journal*, 1892, ii., p. 462) has made a thorough study of nitrobenzol poisoning, and refers to the eye affections as comparatively rare, six cases only having come under his observation in a wide experience.

Simeon Snell (*British Medical Journal*, 1894, ii., p. 449) contributes a complete paper on the ocular lesions in dinitrobenzol amblyopia, and describes five cases, in addition to many examinations among the workers. F. A. Pockley also recorded a case in Australia (*Australas. Med. Gaz.*, Sydney, 1894, xiii., p. 340).

Etiology. *Pathway of entrance of the poison.* Nitrobenzol or dinitrobenzol may enter the system through the mouth, or through

the lungs by the inhalation of the fumes or the fine dust, or through the skin. Workers in manufactories are the ones most exposed, especially to absorption through the integument, or through the respiratory tract.

Snell makes the following interesting observations: "The presence of impure products increases the danger of working with dinitrobenzol. The dinitrobenzol arrives at an explosive factory in slabs, say, of 15 inches square and about 4 inches thick. These are first ground in an apparatus with steam rollers not at all unlike a small mortar machine. In this process a good deal of dust is given off, and the men remark on the smell of bitter almonds. The next step is to take the yellowish powder thus obtained to the mixing-shed, where it is put into a large pan and mixed with oxidizing salts and other materials and heated with steam. It may be put into one of these pans, say, at 7.30 A. M., and be heated until noon. Then it is cooled by cold water being pumped on the outside of the shell. When cool the material is turned out of the 'mixer.' It is during the taking out of the material from the mixer that workmen are especially exposed to the vapor. The dangers are lessened by the adoption of a 'cowl' to the mixer, and also by the use of fans. Thus prepared, the explosive is put away in cylinders and kept until required. The next step is to take it to the filling-room, where it is put into cartridges, wedged and stamped, and finally it goes to the dipping-shed, where the cartridges are waterproofed by dipping them in liquid paraffin wax.

"The most injurious work is that of 'grinding' and 'mixing,' especially the latter. Men are employed in these processes. For the 'filling' of the cartridges, and for the dipping also, women and girls are employed. In the first named the powder is shovelled into the cartridges and directly handled; a good deal of dust is also given off. Respirators and gloves are used, as they are also by the men mixing and grinding. The 'dippers' are the least exposed to the effects, it would appear, but they do suffer. The greasiness about the hands from the paraffin may also aid absorption. Here also gloves and respirators are worn. There is not much dust, the powder being confined inside the cases."

Age, sex, and previous general condition appear to exercise no special influence on the liability to the noxious effect of these substances.

No definite rule can be formulated as to how long "workers" may continue at their employment with impunity. Symptoms of poisoning may come on rapidly, or gradually appear after many months of

occupation, during which the sufferer may often feel the poisonous influence.

As some of the workers have used tobacco, the relation of this drug to the production of amblyopia must be considered. Touching this point, Snell writes: "My men were smokers, but before coming under observation they had reduced the quantity consumed. Further than this, in one case, well observed for a long time, complete recovery took place, whilst tobacco was persevered in without restriction." We may conclude that the carefully reported cases of amblyopia were due to the direct effect of the poison and not to any intercurrent disease or evil habit.

The general symptoms of nitrobenzol poisoning may, as a rule, be thus summarized: headache, muscular weakness and bluish color of the face; later, general cyanosis, disturbed consciousness, dilated pupils, general muscular relaxation, rapid, shallow respiration and thready, failing pulse.

Ocular symptoms. Diminished central acuity, varying from 6/24 to 4/60, normal pupillary reactions, although somewhat sluggishly performed (Nieden), contraction of the visual field, sometimes a color scotoma, and definite ophthalmoscopic changes. The latter are: A darker color of the fundus than normal, "as if stained with ink" (Litten); naturally, or only moderately overfilled arteries, and decided venous hyperemia, the veins being dark, full, and tortuous; pale optic disks, with occasional slight blurring of their margins. Decided extravasations appear not to have been observed, except in Nieden's case, in which there was an exudate near the papilla; small retinal hemorrhages were noted by Litten.

The field of vision for white is concentrically contracted, and also that for color, the blue field being in general smaller than the red field (Nieden); in other words, a partial reversal of the color lines. In some cases there is a central scotoma for red and green (Snell). The visual field-phenomena appear to be similar in each eye; in other words, they indicate symmetrical defects.

The venous hyperemia and discolored fundus oculi are present in those who work in the manufactories, even though they have no visual disturbances. This has been demonstrated by a number of examinations made by Snell.

Diagnosis. This amblyopia resembles that caused by iodoform and bisulphide of carbon in so far as an occasional central scotoma and disturbances in the field of vision are concerned. It also, but less nearly,

is related to tobacco-amblyopia, except that there is contraction of the peripheral visual field. The most distinguishing feature is the ophthalmoscopic appearance; the dark tint of the eye-ground, and the unusually swollen, tortuous, and dark veins are not present in other toxic amblyopias.

If the patient leaves the work in which he is engaged the prognosis is good. Restoration to perfect vision eventually takes place, although some months may elapse before this is accomplished. The serious general conditions which arise in this toxemia may ultimately place the patient in a condition of chronic invalidism.

Pathology and pathological anatomy. The pathology of these cases of poisoning is by no means settled. The effects of these chemicals upon the system, according to Buzzard, Ross, and other writers, suggest multiple or peripheral neuritis, a condition which we know is caused by arsenic, alcohol, lead, and probably bisulphide of carbon. There is also evidence to show that the drug has a centric action and causes death from paralysis of the motor centres.

So far as the eye is concerned it is evident, as Nieden has pointed out, that there is vasomotor paralysis, which would account for the over-filling of the veins, and perhaps indirectly for the retinal exudations which have been observed in a few cases. Finally, it is to be remembered that nitrobenzol belongs to the group of substances which have the power of changing the blood to a deep chocolate-brown and causing it to lose its power of absorbing oxygen.

The scotoma for colors suggests axial disturbance in the optic nerve, although the exact lesion, if such there be, cannot be determined without microscopic examination, opportunity for which has not yet occurred.

The treatment consists principally in removing the patient from the noxious influences of the poison, and the management of his case on general principles. The usual remedies are indicated, namely, strychnin to stimulate the optic nerve and alteratives to help absorb the exudations in the retina and possibly in the nerve fibres. Of these no doubt the bichloride of mercury and the iodide of potassium would fulfil the most important indications.

The preventive treatment of this condition, as well as of the general poisoning, is a matter of importance, and Simeon Snell suggests a number of rules: First, that the different processes should be conducted as much as possible in the open air; second, that in mixing, closed vessels should be employed; third, that fans might be of service; fourth, that in the mixing process some form of respirator should be employed; fifth, that handling of the substances with the bare hand,

or direct exposure to the vapor, should be avoided. As in lead manufactories, great stress should be laid upon proper washing of the hands, etc., after the day's work is done.

See, also, *Nitrobenzol.*

Duboisin. See **Duboisin.** J. P. Worrell (*Trans. Am. Oph. Soc.*, p. 273, 1881) found marked reduction of the visual fields after using this drug for refractive purposes. The fundus was normal, and recovery occurred after three weeks.

Dutch liquid. Consult **Ethylene chloride** in this *Encyclopedia.*

Dyes. See p. 4099, Vol. VI of this *Encyclopedia.* Many of these coloring agents, the coal-tar dyes in particular, produce various forms of amblyopia and amaurosis. See, also, *Anilin*, in this section.

Dynamite. The fumes of this explosive sometimes produce a temporary amblyopia.

Eau de Cologne. See p. 4116, Vol. VI of this *Encyclopedia.*

Eel's blood and bile. An account of these oculotoxic agents will be found on p. 4159, Vol. VI of this *Encyclopedia.*

The irritative action of eel's blood upon the eye was studied by O. Oblath (*Archivio di Ottal.*, xxi., 9, 1914; abs. *Oph. Review*, p. 343, Nov., 1914). Since Angelo Mosso demonstrated the strange toxic reaction upon the conjunctiva which is aroused by eel's blood, even in extremely minute dosage, several papers on the subject have been published. The provocative substance has been labelled "ichthyotoxicum." Among the articles dealing with the resulting inflammation have been those of Pöllot and Rahlson, who described a particular form of conjunctivitis; they experimented to a considerable extent upon certain animals in connection with this. Löhlein's article deals with kerato-conjunctivitis thus produced, as also does Steindorff's.

The local effect upon the conjunctiva, both bulbar and palpebral, seems to be due to a sero-albumin present, for if the globulin be separated and applied by itself to the eye it appears to be innocuous; the toxic substance, whatever it be, is evidently soluble in water.

Oblath has observed a case in his own practice and rightly considers it worth publication in view of the small number of instances as yet recorded. He gives notes to the following effect:—

D.G., while engaged in "cleaning" eels, was struck in the left eye by a spurt of blood and bile; at once there was an intense burning pain and copious lachrymation, and the eye become intensely injected. When seen next day he exhibited moderate redness of the skin of the lids, severe hyperemia of the conjunctiva of the globe with a less degree of the same in that of the lids; at the extremities of the horizontal meridian of the cornea there were two yellowish masses, evidently

pinguecula but larger than the usual form of that tumor, and much injected. There was not a great quantity of discharge but there was considerable lachrymation with photophobia and violent pain. There was no chemosis, and the cornea was not affected; the pupil was round and mobile. Recovery was rather slow, the burning feeling in the eyes and the photophobia diminishing gradually. After all had quieted down and the patient was "cured," suddenly the symptoms returned and the signs reappeared, with infiltration of the cornea at the ends of the horizontal meridian, but no great harm was done and the eye slowly returned to its normal condition again in about six weeks.

There could be no doubt as to the origin of the disease; and it seems well established that eel's blood is capable of setting up just this sort of reaction upon the conjunctiva and cornea. According to Takashima the injurious substance is contained in the blood but not in the bile, the mucosæ, or the contents of the bowel in eels, or at least that if it be it has no effect on the eyes of the rabbit and guinea-pig. Oblath thought it well to repeat the experiments of Takashima, and he found that on introducting some bile into the conjunctiva of a rabbit there was immediate sharp reaction; the eye became red and the animal exhibited a strong desire to rub it: there was some photophobia, and a gradual general return to normal, the cornea, however, remaining all the time quite uninjured; and the eye became normal again in a few days. In order further to test the reaction Oblath instilled more bile into the conjunctival sac of another rabbit, which he had prepared by making a series of wounds in the conjunctiva that the absorption of the toxin might be more rapid; there was, however, no real difference in the two cases. He next diluted the bile with varying quantities of human blood-serum and found that if the mixture was pure copious hemolysis was produced, but to a less degree if it was diluted. Thus the reaction was very feeble when the strength was 1 to 640 and absent when the dilution was 1 to 1280. When human blood corpuscles were exposed to the action of the bile hemolysis at once took place. In the case which he observed there was an unusual feature in that the reaction in the conjunctiva was prolonged for six weeks instead of passing rapidly away, and it will be observed that Oblath is satisfied that the toxic substance was contained in the bile as well as in the blood. The deeper tissues of the eye do not appear to have been affected in any way.

Emetin. See, also, **Ipecac,** as well as **Provoked conjunctivitis.** R. J. Coulter in the *Ophthalmoscope* has reviewed the following papers on this subject. Baillart (*Annales d'Oculist.*, Sept., 1916) has seen

many cases of conjunctivitis in soldiers, produced by the instillation of powdered ipecacuanha. The condition can be recognized by the following characteristics: 1. It is usually, unilateral, and remains so however long its duration, because an attack in one eye is sufficient to get the soldier invalided. 2. There is no secretion-agglutination of the eyelids, and there are no crusts on the roots of the eyelashes. 3. There is frequently slight erythema along the ciliary margin of the eyelid, and occasionally an eczematous condition of the eyelids. 4. There is a pale, dull-red discoloration of the bulbar conjunctiva, most marked in the lower cul-de-sac. 5. The conjunctiva of the upper lid is quite normal. 6. There are no complications.

The discoloration of the conjunctiva may persist for several weeks after the instillations of ipecacuanha are discontinued.

The author adds that the practice was introduced by the Colonial troops, and that the French soldier usually carries the powder in his purse, his watch pocket, or a fold in his képi.

Fromaget and Harriet (*Annales d'Oculist.*, Sept., 1916; review by Sydney Stephenson, *Ophthalmoscope,* p. 670, 1916) have drawn attention to a class where, for the purpose of escaping from military services, soldiers deliberately set up inflammation of the conjunctiva by the application of powdered ipecacuanha to the eyes. The condition, to which attention was first directed by Baillart does not appear to be widely known among medical men, even among ophthalmic surgeons. It presents, however, clinical characters that enable it to be recognized almost at a glance by those familiar with the disease. For example, it is, as above stated, almost invariably unilateral, and affects by preference the right eye. The cutaneous surface of the eyelids is often the seat of a more or less intense eczematous dermatitis. Despite the severity of the conjunctivitis in many instances, secretion is almost always absent. On everting the lower eyelid, the palpebral conjunctiva and that of the cul-de-sac, inflamed and edematous, present a characteristic aspect. The roseate or salmon-hued coloration recalls that of lean ham, and reminds one of that present in cases of spring catarrh, although it is not so white as that of the last named affection. When the irritant has been applied in small quantities or recently, the redness and edema are localized to the lower part of the palpebral conjunctiva, but when, on the contrary, a large amount of the powder has been used, or when it has been applied for long, the changes extend to the whole of the conjunctiva. In some of the cases the condition resembles trachoma, and has been operated upon as such, even by experienced men. Small refringent granulations, resembling grains of semolina, are then disseminated over the tarsal

conjunctiva and the upper cul-de-sac. These pseudo-granulations undergo spontaneous cure in the course of a few weeks, provided the eyes are protected from further irritation, as by the application of a collodion dressing. Diagnostic points are the salmon-like aspect of the conjunctiva, the smallness of the granulations, and the entire absence of corneal complications.

From experiments upon human eyes, the authors conclude that a chemical irritant is the cause of the conjunctivitis, and this they identify as emetin, one of the alkaloids of ipecacuanha. They note that when a 2 per cent. solution of emetin hydrochloride is dropped into the eye, several hours pass before inflammation manifests itself, and a similar remark applies when a morsel of powdered ipecacuanha is employed.

Kalt (*Annales d'Oculist.*, p. 245, June, 1916) has also pointed out that of the many things used by soldiers to produce an artificial conjunctivitis, and thus shirk duty, powdered ipecac is one of those frequently resorted to. Kalt gives a method for gathering even minute quantities remaining in the conjunctival sac with a pellet of guncotton, which is afterwards dissolved in ether and alcohol, and the ipecac particles caught in the collodion, to be subjected to microscopic examination.

In view of the reports of "provoked" conjunctivitis due to ipecac the following histories of John M. Robinson (*Amer. Jour. Ophthal.*, April, 1918) are especially interesting. A 2 per cent. solution of homatropin hydrobromid was ordered for a young woman, with directions to use the drops every half hour, but when she came for her examination there was little or no cycloplegic action, so another bottle was used. At this time there was no redness nor complaint of smarting; but ten hours later she first noticed that the eyes "began to look pink," and at the end of sixteen hours watering and burning were complained of.

Robinson saw the girl twenty-four hours after the original solution had been used: there was then photophobia and profuse lachrymation; the lids were held very tightly closed; there was complaint of burning and smarting, headache and pain radiating through the frontal region. The bulbar conjunctiva was purplish-red, and there was some pericorneal injection; skin of the upper lid slightly edematous; no chemosis; no catarrhal or purulent discharge; cornea clear and the iris apparently uninvolved. This lively reaction persisted for a day or two, and then subsided so that the eyes were again normal in appearance at the end of a week.

The solution used by the girl was examined as to taste, appearance

and chemical reaction: it answered to that of an alkaloidal salt. The pharmacist who had put it up gave assurance that no error had been made. It was then agreed that we had to deal with an idiosyncrasy and as the girl expressed great fear that she was going blind, partly to reassure her, a small drop of the solution was touched to the conjunctiva of Robinson's lower left lid. Twelve hours later he retired for the night, having quite forgotten the small incident.

He was awakened very early in the morning by a sharp sensation, such as that produced by a foreign body on the cornea. The irritation, which was somewhat intermittent in character, continued to increase and was at its height in about eight hours. There was a constant "scratchy" feeling in the eye which became very intense at about five minute intervals, this being accompanied by a spurting of tears from between the spasmodically closed lids, or down through the left nostril—virtually, an ocular tenesmus.

These attacks were at times attended by darts of sharp pain radiating through the infra-orbital and supra-orbital regions. The globe was slightly sensitive to pressure in the ciliary region. Cocain was of no avail, but cold compresses gave some relief. Vision was not actually disturbed, aside from the blurring caused by the active lachrymation. The upper lid became edematous, but there was no chemosis. The pericorneal injection, and the same violet color of the bulb were again present, as in the case of the girl.

In neither case was it possible to examine the fundus. The active sensory disturbance persisted for thirty-six hours, after which there remained marked redness of the eyeball for over ten days. A few pin-point subconjunctival hemorrhages were noted. There persisted through a fortnight a spasmodic myopic astigmatism which at first required—3.50 sph. $\bigcirc$ — 3.50 cyl. axis 180°, above Robinson's normal correction, to bring the vision up to 20/30. For two weeks after this myopia had disappeared the eye was able to read without its normal presbyopic correction of +1.00 sph.

The few drops of the toxic solution precluded a chemical analysis. One drop was placed in a rabbit's eye: there was no reaction for ten hours, but on the day following there was a pronounced congestion. The animal continued to eat, but kept the affected eye closed for two days. Redness was gone in three days. A few known alkaloids were now tried on the rabbit's eye, and it was found that emetin alone—in 2 per cent. strength—produced the identical reaction as to time and degree.

The hydrobromid salt of this alkaloid was kept next to the homatropin bottle in the pharmacy where the dubious solution was prepared.

The evidence was fairly conclusive but Robinson decided to try an experiment on a patient with an old trachoma and pannus. The nature of the procedure was explained, and one drop of a 1 per cent. emetin hydrobromid solution was allowed to remain in the eye for half a minute, and was then washed away. At the end of ten hours there commenced a reaction closely corresponding to those above related, but much milder in degree. The vessels running in the pannus were not found to be much engorged. The course of the disease was not affected.

Contrary to the more common opinion, emetin often acts as an irritant when given in small doses, producing vomiting and purgation. Among the pathologic findings in animals which have been killed by emetin are hemorrhagic swelling of the gastro-intestinal mucosa, and great engorgement of the abdominal vessels with blood. Peripheral neuritis has in several instances followed the administration of ordinary therapeutic doses. The action on the eye then seems to follow quite closely the toxic effects on other organs and parts; moderately slow in action; little effect on the epithelium and superficial vessels, but deep engorgement, and probably direct attack on the peripheral nerves. In Robinson's case the ciliary tenderness, circumcorneal injection, and after-resulting spasmodic myopia point to a special ciliary involvement rather unique in ophthalmic toxicology.

That ipecac powder is irritating to the nasal and bronchial membranes has long been known. A form of "conjunctivitis" has been attributed to the drug. Ipecac also contains the alkaloid cephaelin which has irritant properties aside from those of emetin. Lewin and Guillery describe the effect of "ipecac dust" on the exposed mucous membrane, and they assume that the irritation is due to the contained emetin, and speak even of the possibility of corneal ulceration. But their description, while having certain points of similarity, does not fully correspond to the detail of the cases here reported.

The active principle, or dried substance of many of the drugs which act as emetics or drastic cathartics will on gaining access to the eye surface produce a lively reaction. As in the case of emetin the disturbance may not be immediate nor the attack primarily on the conjunctiva. Veratrum album and veratrum viride are both irritants belonging to this class. The alkaloid veràtrin is more especially dangerous, and may even act as an ocular irritant by systemic absorption. Colchicum and colchicin, lobelia and lobelin, both emetic and purgative in slightly toxic dosage, are local eye poisons.

The acrid milky juice of nearly all of the plants of the genus *Euphorbia* come close to this toxic division. The "American ipecac"

(*E. ipecacuanha*), sometimes used as a substitute for the true Brazilian article, is an eye irritant. The milk of the flowering spurge and the cypress spurge have caused some damage along this line; while "wolf's milk" (*E. helioscopia*), long popular in Europe as a remover of warts, has caused not a little serious eye damage when it has been used on the face. The oriental "mudar and yercum," of the family *Asclepias,* are emeto-cathartic in full dosage, and have some reputation as eye poisons. At least two well-known cathartics, elaterium and podophyllin, have had local ocular inflammation charged to them. In this class croton oil is the arch offender. It waits about ten minutes to commence its destruction. One drop is enough to put out an eye. Castor oil, one of the mildest of oily collyria, is certainly a purgative innocent of damage to the eye, but the castor bean is a mucous membrane irritant of considerable action.

Ephedrin. See **Ephedrin** in this *Encyclopedia.* The action of this alkaloid is to produce mydriasis and the resulting disturbances of vision.

Ergot. de Schweinitz says of this well-known drug that it is interesting chiefly because opacity of the crystalline lens has been observed in connection with ergotism; or, in other words, chronic poisoning with this drug is sometimes followed by the formation of what is technically termed "raphanic cataract." The chief reports of this condition are by Russian observers. See **Cataract, Raphanic,** p. 1574, Vol. III of this *Encyclopedia.*

There is no real evidence to show that the ergot itself produces the cataract; it is much more likely that the lenticular opacity is secondary to the convulsive disorders which the chronic toxemia of the drug induces.

Würdemann supplied the notes of a case of amblyopia, with relative central scotomata, in which ergot was suspected as an etiological factor. Lithemia, alcohol, and tobacco, however, could not be excluded.

Casey Wood's views of the subject are given on pp. 45 and 46 of his monograph. He remarks that Knies, as well as Albutt, speaks of the contractile effects of ergot upon the retinal and nutrient opticus blood vessels, and as a result, marked pallor of the disc. A transitory amblyopia is produced by this vascular contraction and papillary anemia. The pupil is usually dilated and inactive. All these symptoms were well shown in a case of ergotism recorded by Hume where an enema of an ounce of the fluid extract had been administered. Menche observed these same symptoms during an epidemic of ergot-

ism in Ober Hesse forty-five years ago, but he is probably wrong in claiming a case of iritis as due to the effects of the poison.

But by far the most important ocular result of ergotism is the production of cataract. The earliest account is given by Ignaz Meier of twenty-three cases, victims of the epidemic of 1857, in the Siebenbürger district of South Germany. The wet summer produced disease of the rye and in spite of warnings to avoid the tainted bread the ignorant and half-starved peasantry ate it in large numbers; 283 were affected by ergotism of whom ninety-eight died. In the following year Meier saw fifteen women and eight men affected with slowly progressive (several months to a year in forming) cataract of the senile type. Both lenses were affected and the ocular disease seemed to confine itself to the crystalline; the retina, vitreous and opticus were healthy, and the extraction of the cataract was uniformly successful. Kortnew, during the widespread 1889-90 epidemic in the Russian Njatka government (caused by diseased rye meal, which affected 2,000 persons), had an excellent opportunity of studying the eye symptoms of this formidable disease. These set in about two months after the beginning of the epidemic and are divided by him into two groups; the first complained of intermittent failure of vision coming on in some instances several times a day, sometimes only once a week, and in others at longer intervals. The average number of attacks during the whole illness was from three to five. None of these patients complained of total or permanent loss of vision.

With the second class of cases it was quite different. The loss of vision not only persisted but got gradually worse as the convulsive seizures, due to the poison, continued. In every such instance opacities were found in the crystalline, which presented the smoky-gray appearance of senile cataract. In all the instances of this kind, thirty-seven, the opacity spread from the center towards the periphery, and in from three months to a year became complete. Little children were blind in from two to three months; adults over forty took longer, from eight to twelve months. The extraction of such cataracts was ordinarily successful except that there was an unusual loss of vitreous.

Tepljaschin examined twenty-seven cases of this form of cataract in Russians affected by the disease and found the same conditions reported by Kortnew.

(This subject continued in the following volume.)

F. A. SMITH